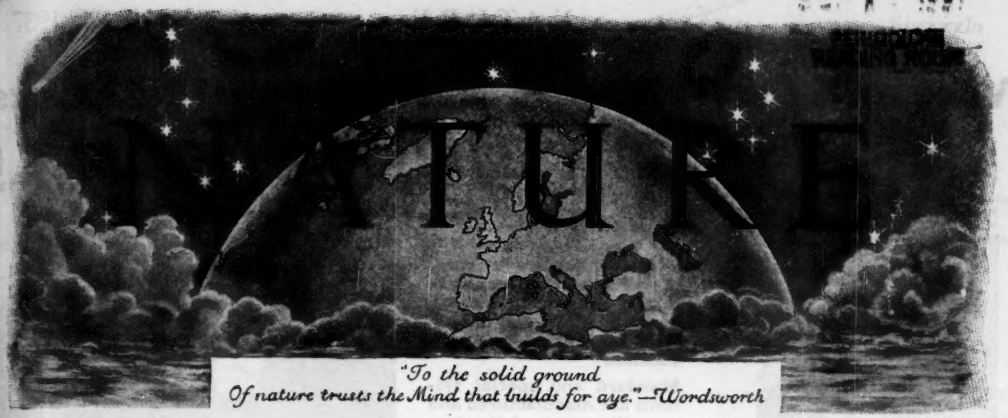
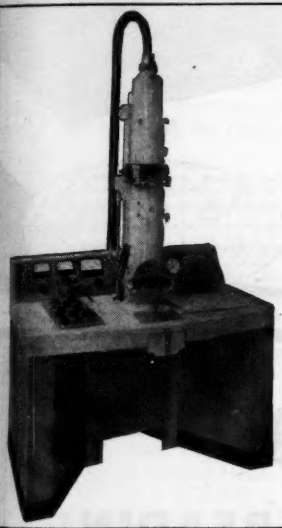
OF MICHIGAN
LIBRARY
1957



"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 180, No. 4582 SATURDAY, AUGUST 24, 1957 2s. 6d.



AT YOUR SERVICE—

— a fully equipped electron microscope laboratory staffed by experienced operators

Write for details and charges to:—

SCIENTIFIC APPARATUS DEPT.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER 17

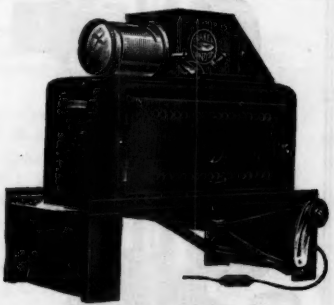
An A.E.I. Company

N/R701

For projection perfection . . .

. . . the 'British' Epidiascope is fitted with silent twin cooling fans and has a large specimen platform in an undercarriage which is easily interchanged with a castor mounting for movement over unlimited areas. A simple lever movement selects either epi- or diascopic projection through the same lens and without change of focus.

Price £116 12*s.* 0*d.*, *ex Works*
Immediate delivery—write now for illustrated list



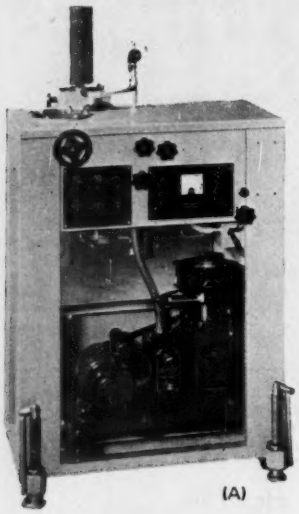
The 'British' Epidiascope

C. Baker
OF HOLBORN LTD. EST 1765

C. BAKER OF HOLBORN LIMITED
METRON WORKS · PURLEY WAY · CROYDON SURREY
CROydon 3845/6/7

Vacuum Leak-Testing to the order of 10^{-5} Lusecs

—INDUSTRIALLY!



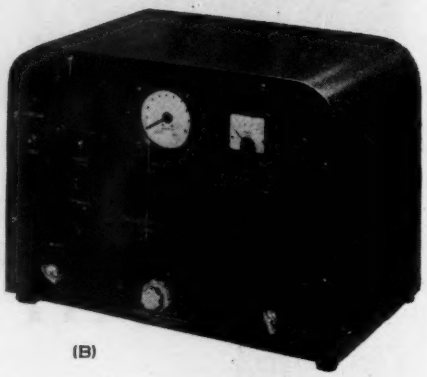
(A)

We manufacture a complete range of vacuum leak-testing equipment to cover every scientific and industrial application of high vacuum.

Standard and special systems are manufactured and we illustrate but two examples . . .

(A) A special vacuum pumping system complete with high speed rotary and vapour pump combination, precision vacuum gauge and rapid assembly type connections

(B) PALLADIUM-BARRIER LEAK DETECTOR. An ultra-sensitive tester which rapidly pinpoints leaks of the order of 10^{-8} lusecs

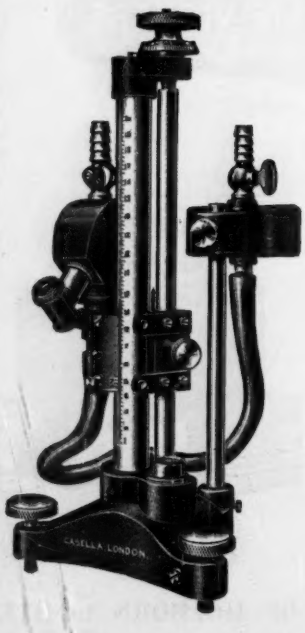


(B)

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY



CASELLA LONDON

MICROMETER READING MANOMETER

Reading to 0·001 inch of water

This instrument, which has a total range of 0–6·75 inch (0–170 mm.), enables readings to be taken to 0·001 inch (0·01 mm.) over the full range of the micrometer.

This Manometer is available for early delivery and full particulars will be supplied on application

C. F. CASELLA & CO. LTD.

Regent House, Fitzroy Square, London, W.1

Telephone: ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain

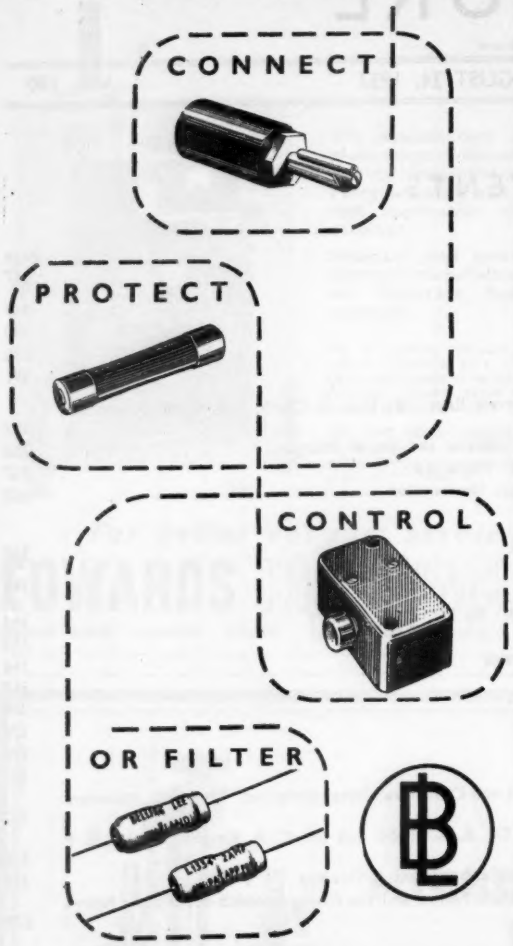
NATURE

No. 4582 SATURDAY, AUGUST 24, 1957 Vol. 180

CONTENTS

	Page
Progress and Responsibility in Industry	347
Life in the Abyss. By Dr. L. Harrison Matthews, F.R.S.	349
Global Atomic War. By William Cooper	350
Eels. By Dr. E. Trewavas	350
Ecologists in the Laboratory. By Dr. S. D. Garrett	351
An Experiment on Air Showers produced by High-Energy Cosmic Rays. By Drs. G. Clark, J. Earl, W. Kraushaar, J. Linsley, B. Rossi and F. Scherb	353
The Canada Council for the Encouragement of the Arts, Humanities and Social Sciences	356
Flow of Steam–Water Mixtures at High Pressures. By R. W. Haywood	357
Hazards associated with the Development of Weapons of Mass Destruction	358
Obituary :	
Mr. R. G. K. Lempfert. By E. Gold, C.B., O.B.E., F.R.S.	360
News and Views	360
New Research Headquarters of Thomas Hedley and Co., Ltd. By Dr. E. R. Wilson	364
Hatfield Technical College. By Dr. W. A. J. Chapman	365
Modern Analytical Chemistry in Industry. By Dr. G. R. Davies	366
Electronics in Automation. By L. H. Bedford	369
Tensors in Electrical Engineering	369
Royal Botanic Gardens, Kew. By Prof. C. W. Wardlaw	370
The Civil Service	371
Accidents in Childhood	371
Relationship between the Hydrolysis of Adenosine Triphosphate and Oxidative Phosphorylation. By W. C. Hülsmann and Prof. E. C. Slater	372
Terminal Groups of Tobacco Mosaic Virus Nucleic Acid. By Dr. K. K. Reddi and Dr. C. A. Knight ; Dr. R. E. F. Matthews and Dr. J. D. Smith	376
Genetics of the β-Lactoglobulins of Cow's Milk.—By R. Aschaffenburg and J. Drewry	376
Histochemical Appearances of Cholinesterase in the Normal Sciatic Nerve and the Changes which occur after Nerve Section. By Dr. R. S. Snell	378
Letters to the Editors :	
Hole and Claw Defects in Graphite.—Prof. A. R. Ubbelohde, F.R.S.	380
Sources of Radio Noise on the Planet Jupiter.—C. H. Barrow, T. D. Carr and Prof. A. G. Smith	381
Short Time Transients in Solar Noise.—T. de Groot	382
Determination of Radon and Thoron in Air.—G. B. Courtier	382
Sites of the Incorporation of an Amino-acid into Proteins of *Bacillus megaterium*.—Dr. G. D. Hunter, Dr. A. R. Crathorn and Prof. J. A. V. Butler, F.R.S.	383
A Rapid Procedure for the Separation of Amino-Acids on Paper Chromatograms.—Henry R. Roberts and Michael G. Kolor	384
A Convenient Method for labelling biologically interesting Carboxylic Acids with Tritium.—N. P. Buu-Hoï	385
Internal Structure of the Virus-like Particles associated with the Rous Sarcoma, and their Presence in other Neoplastic and Normal Chicken Tissues.—Prof. Ch. Oberling, W. Bernhard and Ph. Vigier	386
Intestinal Lecithinase.—B. Epstein and B. Shapiro	387
Sensitivity of Pancreas Hexokinase towards Alloxan and its Modification by Glucose.—Dr. C. Villar-Palasi, Dr. A. Carballido, Dr. A. Sols and Prof. J. L. Arteta	387
Field Evidence of Density-governing Reaction in *Sminthurus viridis* (L.).—M. M. H. Wallace	388
Dwarf *Drosophila* produced by Ethylene Diamine Tetra-acetic Acid : a Relationship to Chelation of Zinc.—Dale Steffensen	390
Polymorphism in Human Trypanosomiasis.—Dr. D. J. B. Wijers	391
Chromosome Polymorphism in the Common Shrew.—Dr. C. E. Ford, J. L. Hamerton and G. B. Sharman	392
Significance of Vacuolated Neurones in the Medulla of Sheep affected with Scrapie.—I. Zlotnik	393
Improved Persistence of Dieldrin Deposits on Sorptive Mud Surface.—Ph. Gerolt	394
Sensitivity of Light-inhibited Seeds to Certain Spectral Regions.—M. Black and Dr. P. F. Wareing	395

IF YOU NEED TO



. . . there are "Belling-Lee" components tailored to your requirements by over thirty-five years of "know-how"

Full details of our range of components are available in the "Belling-Lee" General Catalogue. If there is not a copy in your establishment please write to us.

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND
Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

ELECTRONIC COMPONENTS

Announcing a new series of special publications!

GRIFFIN'S STATISTICAL MONOGRAPHS & COURSES

Edited by M. G. KENDALL, Sc.D.
Professor of Statistics in the University of London

This Series has been planned to meet the need for a form of publication, at moderate cost, which makes accessible to a group of readers specialized studies in statistics or special courses on particular statistical topics. Appearing in a standard cover, the text printing method used for each volume will suit the complexity or otherwise of the subject.

No. 1. *Just published*

MULTIPLE TIME-SERIES ANALYSIS M. H. QUENOUILLE, M.A.

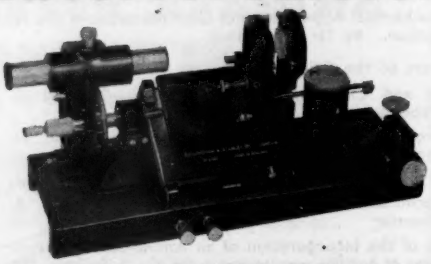
CONTENTS: Preface — Introduction — Specification — Identification — Preliminary Investigation — Practical complications — Estimation — Significance and Goodness - of - Fit Tests — Practical Examples: U.S. Hog Series — List of Symbols — References.

108 pages. 8½″ × 5½″. 24s. net, Postage 6d.

CHARLES GRIFFIN & COMPANY LTD.
42 DRURY LANE LONDON W.C.2

PRECISION BS INSTRUMENTS

Fabry-Perot Interferometer



Although of very simple design, this instrument is suitable for much of the work usually carried out by more elaborate and costly apparatus, and reads directly to 1/250 mm. It can be supplied with an attachment to convert to a Michelson interferometer, thus giving a dual purpose instrument.

Price Complete **£190 0s.**
Attachment for converting instrument into Michelson Interferometer, extra £45 0s.
Polished wooden case, extra £9 10s.

Bellingham & Stanley Ltd.
DEPT. N, 71 HORNSEY RISE, LONDON, N.19
PHONE: ARCHWAY 2270

PROGRESS AND RESPONSIBILITY IN INDUSTRY

MR. JULIAN M. LEONARD'S presidential address at Leeds to the Society of Chemical Industry delivered on July 9, and Dr. W. J. Worboys's address as the Society's medallist on the following day, were curiously complementary. They were also in the same pattern as Sir Alexander Fleck's Messel Memorial Lecture to the Society last October, and some of the points made by Mr. Leonard and Dr. Worboys bear closely on the current discussions on technical change which have been stimulated by the recent report by Prof. C. F. Carter and B. R. Williams on "Industry and Technical Progress". Sir Alexander, it may be recalled, was prompted both by the life and work of Messel and by the celebration by the Society of its seventy-fifth anniversary to look back over that period in chemical industry and to ask some pertinent questions about the rate of progress—whether it could be maintained, whether research in the industry was wisely directed and, especially, whether the rate of development was sufficiently in line with both economic and social requirements.

Sir Alexander's emphasis on the social aspect and his reference to Sir Philip Morris's remark that industry cannot afford to operate in a cultural desert was reflected more especially in Dr. Worboys's address. Mr. Leonard's review of the era of change—the term by which he designated the past eighty years of chemical industry—was concerned more especially with the economic and legal factors which now circumscribe the initiative and enterprise of existing manufacturers and still more of those who seek to undertake new manufactures. Sketching the different conditions which to-day confront the pioneer, he did indeed indicate that those conditions are the expression of a larger sense of social or public responsibility; but the picture he presented was one that gave sufficient evidence of obstacles which the community has itself created to enterprise and development. In the aggregate, the Factory Acts the Explosives Acts, the Petroleum Acts, the Alkali, etc., Works Regulation Act, the Electricity Regulations, the Distribution of Industries Act, the River (Prevention of Pollution) Act, the Clean Air Act, to name only some that Mr. Leonard mentioned, however wise and essential they may be, do in fact constitute a check to enterprise, and it is well to be reminded that for such safeguards the community itself has to pay a price.

Mr. Leonard did not discuss monetary policy or marketing in any detail, and in his reference to labour policy and industrial relations he clearly agreed with what Sir Alexander Fleck had said in his Messel Memorial Lecture. However, he frankly expressed his anxiety whether, in the face of the conditions he described and especially those which we ourselves as a State have created, existing small chemical businesses—which still comprise the bulk of the industry—can continue to prosper, and new entrants to the industry can succeed, in their ventures; and he remarked that this position represents a challenge. Sir Alexander Fleck has emphasized the contribution which chemistry and chemical industry are making to our national wealth, and Mr. Leonard observed that the industry must of necessity take an increasingly important place in an expanding world economy and that the backward countries and underdeveloped areas might in the future offer new opportunities and fields of expansion. The difficulties to which he directed attention arise only to be surmounted by those with resolution, courage and vision, and especially the ability to adapt themselves to changing conditions.

Dr. Worboys referred even more explicitly than Mr. Leonard to the impact of chemistry on daily life, as well as on transport and communications; but, in the picture of our world which he drew in this address, he was concerned to point to changes in the political as well as in the economic position of Britain—which are sources of both strength and weakness—and to their implications. Although British exports of manufactured goods in 1955 were approximately ten times the value of exports in 1900, Britain now accounts for only 10 per cent of the Western world's production of manufactured goods, compared with 20 per cent in 1900. Moreover, he believes it would be wrong and dangerous to assume that in the future the United Kingdom must be mainly an exporter of capital goods and that consumer goods have only a small part to play in the country's exports. To be sure of sharing in this trade, British products must be of good design and good quality, and sold and serviced with vigour and real knowledge of the requirements of the overseas markets and the competition to be met.

In producing such products—and especially novel products—established technologies and wide industrial experience are great assets, but Dr. Worboys pointed out that the expanding home market in Britain resulting from the doubling of the national income per head of the population during the past fifty years is a source of weakness as well as of strength. While a healthy home market provides a good base for exports, competing demands at home could reduce the tonnage available for export unless the manufacturer is prepared to take risks and invest in additional plant. Here the factors stressed by Mr. Leonard operate, and the increased imports necessitated by increasing production could also be a source of weakness, as could the political changes to which Dr. Worboys next referred, in the absence of a growing sense of responsibility.

Universal suffrage and not nuclear energy, suggested Dr. Worboys, is the greatest uncontrolled force

in our lives, politics being the pursuit of power; and power, in a democracy, being decided by elections. That is an over-simplification and ignores the factor of influence, but Dr. Worboys did well to remind us that a political system based on universal suffrage has weaknesses as well as substantial and precious advantages. The challenge of reducing those weaknesses to a minimum has been more commonly evaded than faced, and Dr. Worboys's suggestion that the best, if not only, hope lies in a growing sense of responsibility throughout the spectrum of adult population and less group and individual selfishness has been promptly underlined by subsequent events.

What perhaps seems even less certain than when he spoke is that education is the only method, and whether group selfishness in particular will allow the time required for that slow process. None who occupy positions of authority or influence can ignore, however, his responsibility for seeing that the attempt is made, or for challenging policies that are based on fallacies. Unless the responsibilities of industrial leadership are fairly accepted and faithfully discharged, a common level of poverty rather than higher living standards for the mass of the people is likely to result.

The clear thinking which Dr. Worboys urged need not involve party politics; but it does involve the acceptance of political responsibilities as citizens and responsibility for leadership in industry. Dr. Worboys was concerned primarily with the health of British industry in general, but his prerequisites are no less valid for the nationalized industries and public services than for the chemical industry. Political climate apart, his four conditions—good research, good technological development, good commercial exploitation and good personnel policy—are valid generally, and deficiencies in all four sectors have probably contributed in greater or less degree to the unhappy situation in road transport, for example. All can contribute to the effective team-work which is the condition of success in the public services as in manufacturing industries. When all concerned recognize the objective and are in sympathy with it, the disputes and bitterness that are too common to-day will disappear.

Dr. Worboys suggested that the senior managers in industry bear a heavy responsibility for starting or accelerating the educational processes which alone can bring about real team-work in industry. It is their responsibility to recognize what are the requirements for an industry to be healthy and to see that those requirements are understood by the Government, the administration and by members of Parliament. This will require conscious effort and is not a task that can be left to the public relations or internal relations officers, although their techniques might be able to help.

Dr. Worboys did not hesitate to affirm that Britain's wealth is, in the main, the sum of the profits of all the companies operating in or from the United Kingdom, and, like Mr. Leonard, he emphasized the importance of under-developed areas as markets, urging that we should be concerning ourselves with the expansion of markets and the creation of new ones, especially through the raising of the standard of living among the people of Africa, India and Asia. Here, like Mr. Leonard, he indicated the necessity of being ready to face change, particularly in the pattern of production and exports. In connexion with the growing international competition as well as with the development of team-work in industry and the furtherance of the public understanding of the purposes and needs of industry, it falls, he suggested, within the sphere of activity of the Society of Chemical Industry to create a new group or section or to make some other arrangement for the discussion by its members of matters touching on the health of British industry. He was particularly insistent on the need for more profit-producing work to be put in before more profit is taken out either as dividends, wages or taxes.

There is *prima facie* evidence in all three of these addresses that such matters bear closely on the continuing practice of applied chemistry; but here, and in the two points he stressed in closing, Dr. Worboys touched on matters which equally involve the creation of an appropriate political climate. Men are not equal, he asserted, and the most we can do is to ensure that all children have equal opportunities to develop. By doing so, we can ensure that the best use is made of the country's prime asset—its people.

That is a further reason why educational policy is of outstanding importance, though from a wider angle than that from which it was considered in the recent conference at Leeds, which was concerned primarily with the supply of scientists and technologists for industry. Dr. Worboys's emphasis on management, however, in itself indicated the supreme importance of a supply of able minds, of character as well as of intellect; but the stress here lies on the creation of a climate of opinion which will ensure that educational opportunities are not destroyed in the service of party political doctrine or prejudice. His second point—the pressing need for the re-creation of incentives—is no less largely a matter of the climate of opinion; indeed, in so far as Dr. Worboys is right in holding that in the United Kingdom the improvement of monetary incentives is mainly a question of taxation, it could easily become a matter of party politics.

If that be so, it is the more important that this aspect of taxation policy should be the subject of impartial and authoritative inquiry, so that opportunity should be given for the creation of an independent body of opinion to enforce action demanded in the country's interest, even if it is not in line with party doctrine. It is disappointing to find that the recent conference on "Capital for Scientific Development" held at the Royal Society of Arts scarcely faced such issues, although Prof. C. F. Carter at least put some of the necessary questions (see *Nature*, August 17, p. 307). Finance may well be a less serious problem than the shortage of scientists and technologists and the quality of management, as Prof. B. R. Williams said at Leeds; but the creation

of healthy conditions for industry is largely a matter of removing hindrances and establishing the confidence and understanding which promote co-operation and goodwill. We need more such realistic addresses as that by Dr. Worboys, with its fearless facing of awkward questions, more impartial inquiry and more clear thinking and honest acceptance of responsibility. For its example as well as for its stimulus to such thought and endeavour, Dr. Worboys has earned the gratitude of a much wider circle than members of the Society of Chemical Industry. It is well to be reminded of how much food supply, health, transport, communications and comfort depend on chemical industry and on industry in general; but we need still more to be reminded at this time that the prosperity of industry depends equally on the state of the nation. Unless we provide the conditions which encourage and reward responsibility, ability and constructive work, we are unlikely to find the new answers to old questions which are demanded if Britain's economic future is to be secure in this modern world.

LIFE IN THE ABYSS

The Galathea Deep Sea Expedition, 1950–1952
Described by Members of the Expedition. Edited by Dr. Anton F. Bruun, Sv. Greve, Hakon Mielche, and Dr. Ragnar Spärck. (Translated from the Danish by Reginald Spink.) Pp. 296. (London: George Allen and Unwin, Ltd., 1956.) 40*s*. net.

AN exploring voyage with a deep sea expedition must be one of the most stimulating experiences that a biologist can enjoy—no marine biologist would willingly forgo the opportunity of serving in one. Since the days of Edward Forbes and the *Challenger*, much knowledge of the depths of the oceans had been accumulated as the result of expeditions sent out by many nations, but the most long-sustained studies must surely be the researches made in the southern oceans by the ships of the *Discovery* investigations which continued for nearly a quarter of a century. Denmark has made her full contribution to the exploration of the sea, from the cruise of the corvette *Galathea* a little more than a hundred years ago to the researches of Johannes Schmidt and his culminating *Dana* world expedition. Another Danish expedition to study the greatest abyssal depths had been under discussion for some years, but it was not until 1948 that serious planning could be undertaken, planning that resulted in the sailing of the *Galathea*, formerly the sloop H.M.S. *Leith*, on her circumnavigation of the world in October 1950.

The primary purpose of the *Galathea* expedition was to explore the ocean trenches in depths exceeding 6,000 metres in order to find out if life occurred under the extreme conditions prevailing there. Large-scale dredging was to be carried out to find whether, and to what extent, there are large and active animals in the abyss and at somewhat higher levels. Quantitative methods were also to be used for studying the fauna of the shallower tropical seas as well as the great depths. Many other subsidiary lines of research were to be carried out provided they did not interfere with the main objects. In addition, visiting scientists were encouraged to join the expedition for limited periods, at ports of call an endeavour to spread a knowledge of Danish culture was to be made by means of films and lectures, and films and recordings were to be made for broadcasting over the Danish radio.

This was indeed an enormous task, and the expedition's return with so much of it successfully accomplished was largely due to the energy and wisdom of its leader, Dr. Anton F. Bruun, who makes handsome acknowledgment to his staff and colleagues. The present volume is a popular account of the work of the expedition written by its members, each of whom contributes a chapter or two on his own speciality. Technical matters are explained so that the layman can understand the conditions of life in the sea, especially at great depths, and some of the problems of oceanography and the methods of studying them. The book is ably translated from the Danish by R. Spink, and is well illustrated with drawings and photographs. The fact that it was set up and printed in Denmark no doubt accounts for a number of misprints, most of them obvious and of minor importance.

The subjects of the chapters vary widely, from echo-sounding and the technique of trawling, to sea snakes and geomagnetic investigations, but those of greatest interest to marine biologists are probably the ones dealing with the fauna of the abyssal trenches, the Philippine, Kermadec, Tonga, and other trenches. In the first of these deeps specimens were obtained from depths of more than 10,000 metres and included coelenterates, echiuroids, holothurians and bivalve molluscs. At these great depths, too, large quantities of waterlogged vegetable debris derived from the land were found—sticks, branches, leaves, palm and mangrove fruits, and much else. It is commonly believed that a rain of dead plankton animals sinks to the bottom from the surface layers. Dr. Bruun points out that dead organisms are as rare a sight in the sea as they are on land. "Sick or weak animals fall a prey to stronger enemies and are devoured. . . . The microscopic plants sink very slowly, and must be consumed in the first few hundred metres; lower down they can certainly be traced only in very scanty quantities. This, no doubt, is why the discontinuity layer between the water masses in the warm, upper thermosphere and the cold, deeper psychrosphere . . . is so rich in pelagic animals." In this layer the cold of the deep stops the animals from above, and the warmth of the upper layer stops those from below. Beneath the layer very little food is available, for it has nearly all been eaten, and for thousands of metres below it higher animal life is very sparse. But on the bottom where everything not already eaten comes to rest, especially land-derived plant remains the cellulose of which is not digestible by most pelagic animals, the fauna is much richer than in the barren tract between the discontinuity layer and the bottom. Whenever the trawl came up from the great depths with a bag-full of plant remains the zoologists knew at once that a good catch of animals would be revealed when the contents of the net were emptied. "Dead vegetable material of this kind can hardly be broken down by the gastric juices of animals; but bacteria can cope with both cellulose and with everything else, and they in turn can be consumed by mud-eaters which gorge themselves on the soft oozy bottom, such as the bristle-worms, sea-cucumbers, and bivalves. And

then a new link can be added to the food chain; namely, crustaceans, which eat the worms and in turn are eaten by fishes." Dr. C. E. ZoBell, of the Scripps Institution of Oceanography, who accompanied the expedition for part of the time, was able to demonstrate the presence of large numbers of bacteria in the mud from the greatest depths, and to grow them in culture media under pressures of up to 1,000 atmospheres and at low temperatures—conditions approximating to those found in the abyss. He showed that they were truly barophilic because there was no growth in the cultures subjected to atmospheric pressure. "Although from 0·0002 to 0·02 grams of bacteria per square metre of ocean floor may be considered a small 'standing crop' as compared with the crops harvested from fertile garden soil, this amount compares favourably with the total weight of animals found by zoologists on the *Galathea* Expedition."

The main object of the expedition was to explore the greatest depths, and undoubtedly one of the most important biological results achieved was this elucidation of the ecology of the abyss, and the demonstration that the idea of a constant rain of food material from above is a misconception. The basic food material does come from above, but far from being a product of the sea derived from planktonic organisms, it is directly derived from the land in the form of the cellulose of higher plants.

This book gives an absorbing account of the progress of the expedition, and an excellent general view of the scientific results obtained. Specialists will look forward to the appearance of the detailed monographs reporting on the very large and important collections that were brought back, which will no doubt be presented in the form of a series of volumes to be published over a number of years.

L. Harrison Matthews

GLOBAL ATOMIC WAR

On the Beach

By Nevil Shute. Pp. vi+312. (London: William Heinemann, Ltd., 1957.) 15*s*. net.

THE theme of "On the Beach" is the extinction of the human race resulting from an atomic war. Everybody dies. Just that.

When the novel opens, in Melbourne, 1962, nobody is alive in the northern hemisphere. Movements of the atmosphere are steadily carrying lethal particles southwards. Mr. Shute has deployed his remarkable imagination as engineer, naval officer and story-teller—there is a fascinating account of an atomic-powered submarine's voyage along the coast of the 'hot' North American continent—in the service of an aim which would appear to be above all a moral one. On his immense popular following this book can only inflict a haunting distress: one takes off one's hat to him.

Mr. Shute has limited his canvas: he has taken only five main characters—five very ordinary people at that; and he has pitched the emotional and dramatic tone invariably low. Until the moment when the radiation sickness comes on, everybody sticks to the tamest of domestic preoccupations; and then quietly takes a suicide pill. The effect is hypnotic, and also odd. Mr. Shute's world ends not, as the epigraph warns, with a whimper, but with a stoical silence, movingly impressive—if one were not nagged by the thought that Mr. Shute either could not or would not create someone with a wild uncontrollable reaction to catastrophe.

The moral, in so far as Mr. Shute states it explicitly, comes via his characters thus: "Maybe we've been too silly to deserve a world like this", and "The only possible hope would have been to educate them out of their silliness". Again something falls oddly, and flatly, something which tends to be characteristic of 'scientific' novels of the Wellsian kind. Like Wells, their authors, it seems to me, recognize readily in human nature "the white thread of intellect and the scarlet thread of passion"; they miss the black thread of ineradicable destructiveness. (On the other hand, 'literary' novelists of the past thirty years have tended to recognize the scarlet thread and the black, and notably to leave out intellect.) 'Silliness' would seem to mean to Mr. Shute something connected with weakness of intellect. To my mind the enemy hides deeper in us, and elsewhere; and Mr. Shute does not really get at him. But one takes off one's hat all the same.

William Cooper

EELS

Eels

A Biological Study. By the late Prof. Léon Bertin. Pp. viii+192+8 plates. (London: Cleaver-Hume Press, Ltd., 1956.) 25*s*.

THE French title "Les Anguilles", freshwater eels, indicates that this book is a study of a single species, but this is not merely the only comprehensive account in English of the life-story and bionomics of the European eel. It aims at illustrating a number of aspects of biology and methods of research by reference to a single animal. The dramatic and once baffling life-history of the eel, as well as its economic importance, has focused attention upon it through the centuries, but it is only during the past half-century that the techniques have been developed for studying its osmotic relations during its migrations from salt to fresh water and back again, or for statistical analysis of the populations to test the homogeneity of the species, or for appreciating the role of the endocrine organs in controlling its migrations. Nor in other centuries could the problem of its sexuality and sex determination even have been defined.

A student with an elementary training in zoology to the Higher School Certificate or First Medical examination standard can read this book with profit, and come away with some understanding of the problems presented by the eel to human curiosity and of the methods of attacking them, often groping at first, but becoming more precise as understanding and technique developed. Prof. Bertin makes his study of eels also a study in the history of zoological science, presented in a literary style which enables the reader to share the excitement of discovery and emulation. Each chapter is followed by a list of references, among which we miss the complete reference to Schmidt's Royal Society paper of 1922 (although this is referred to in the text) and—an unfortunate omission for English readers—any notice of Dr. Frost's account in 1945 of the freshwater life of the eels of Windermere.

The translation runs well, but could be bettered here and there. 'Expérience', for example, should usually be translated 'experiment'. There are some serious misprints—'thiner' (*sic*) for 'plus épaisse' on

p. 95 and 'differentiation' for 'dédifferentiation' on p. 77. Aristotle's view of eel life-history was probably less naïve than it is here painted. The name *Leptocephalus* was not, as the book states, first given to the larva of *Anguilla*. It was invented in 1763 by Gronovius for a larva of a conger eel sent to him by Pennant (although both, of course, were unaware of the relationship between larva and adult), long before Kaup put *L. brevirostris*, now known to be the larva of *Anguilla*, in the same 'genus'. It is worth mentioning that it was in the conger eel that the metamorphosis was first observed, by Delage in 1886, thus providing the analogy for the demonstration ten years later of the identity of *L. brevirostris* and *Anguilla* by Grassi and Calandruccio.

This book should appeal to a wide range of readers, and it is to be hoped that new editions will be called for in which not only some improvements can be made, but also the results of work still in progress may be incorporated to keep it up to date.

E. TREWAVAS

ECOLOGISTS IN THE LABORATORY

Microbial Ecology

Seventh Symposium of the Society for General Microbiology, held at the Royal Institution, London, April 1957. Edited by R. E. O. Williams and C. C. Spicer. Pp. ix+388+6 plates. (Cambridge: At the University Press, 1957. Published for the Society for General Microbiology.) 32*s*. 6*d*. net.

THE complex interlocking social structure of most natural communities of organisms is determined first by the selective action of the habitat, and secondly by the interactions of its inhabitants. It is the business of ecology to understand these relationships; all biological information can be used, and eventually must be used, by the ecologist as raw material for his study, yet the amassing of this raw material is only a first step in the elucidation of ecological relationships. Ecology has been an overworked word, and some microbial ecologists may have entertained private doubts as to whether the symposium volume here under review would represent a genuine and substantial contribution to ecology, rather than a mere rag-bag of assorted microbiological data in search of a collective title. Happily these hypothetical fears have been proved groundless by the actual event.

It is much to be hoped that ecologists in general will read this symposium volume, if only to realize that microbial ecology is now a branch of the subject in its own right, and not merely a provider of microbiological information useful, for example, to plant ecologists interested in the behaviour of roots, or in the availability of soil nutrients. Microbial ecology, owing to its greatly compressed space and time relationships, lends itself peculiarly well to laboratory study; as physiologists, biochemists and geneticists have also demonstrated, micro-organisms offer many advantages over higher animals and plants as experimental subjects.

To this volume, eighteen authors have contributed seventeen papers, distributed fairly evenly over the field of contemporary research. I should like to comment on every paper, but I must restrict myself to a short list of those contributions which I think most nearly represent the whole subject, or which consider particular aspects of general interest. Other reviewers, with other special interests, might have made a different but equally good selection; nevertheless, I am certain that any reviewer would find an excuse to mention the outstanding paper by R. Y. Stanier and Germaine Cohen-Bazire on the role of light in the microbial world. It seems impossible for Prof. Stanier to write a paper that is dull even in part, and this one fully repays the attention that its closely-reasoned arguments demand.

Although Dr. Jane Gibson's paper is concerned with nutritional aspects of microbial ecology, yet I think it succeeds better than any of the other contributions in explaining very clearly the whole subject, and this is perhaps the best paper to read by way of introduction to the others. Incidentally, it includes one of the best short histories of soil microbiology that I have read. Whereas Dr. Gibson has confined herself to the microflora of soil and other habitats, a similar broad survey serving as an introduction to microfaunal ecology has been made by Dr. J. A. Kitching in his article on the free-living Protozoa; both he and Dr. Gibson epitomize the 'oscillating process' whereby research on microbial ecology must proceed, by the alternation of field surveys and laboratory experimentation, giving progressively closer approximations to the truth.

A paper by Dr. H. T. Tribe is noteworthy not only for its description of an elegant new technique for studying the development of a succession of micro-organisms on buried cellulose film, but also for the fact that equal attention is devoted to microflora and microfauna. This is one of the most comprehensive and convincing studies of a microbial succession on a selected substrate yet to have been published. Dr. P. W. Brian's paper, on the ecological significance of antibiotic production, is certain to be widely read; here we can see how the ecologist's approach has clarified a problem of absorbing interest to many microbiologists. Only Dr. Brian, with his unique experience of the whole subject, could have discoursed with so much insight on this problem. The amount of nonsense that has been written on this subject in the past, though admittedly not by ecologists, makes the recent progress reported by Dr. Brian all the more gratifying.

Mr. F. C. Bawden's article on the role of plant hosts in microbial ecology has been as well placed in this symposium as an astringent draught in an over-long banquet—towards the end, where it is needed. I do not agree with all that Mr. Bawden has said, but I imagine that he would be dismayed if I did; he seeks not to impose agreement, but rather to provoke a more sceptical spirit of inquiry, and he has certainly succeeded in making me re-examine my own convictions. He rightly criticizes the tendency to premature generalization, and remarks that every ecological situation is best considered as though it were unique.

In the course of his paper, Dr. Kitching has incidentally deplored the "academic estrangement of bacteriology from zoology"; the publication of this symposium will at least help those to help themselves who wish to reduce the worst consequences of a cleavage that starts in the classroom. The editors, Drs. R. E. O. Williams and C. C. Spicer, are to be congratulated on the results of their unobtrusive but not inconsiderable labours.

S. D. GARRETT

The Constitutional Diagrams of Alloys

A Bibliography. Originally compiled by Dr. J. L. Haughton. Second edition compiled by A. Prince. Pp. 324. (London: Institute of Metals, 1956.) 35*s*.; 5.50 dollars.

THIS bibliography is of great value to physical metallurgists, or anyone else who wants to find out quickly what work has been done on the constitution of a particular alloy system. The first edition appeared in 1942 and the present edition, which is about twice as large, covers work published up to the end of 1954, and for some journals until the middle of 1955. There are more than two hundred pages of entries on binary alloys, approximately eighty pages on ternary systems, rather more than ten and less than one, respectively, for quaternary and quinary systems, and one entry for a senary system. It is following a somewhat worn path to point out how well these figures (they are in a very rough way inversely proportional to the possible number of alloy combinations) emphasize the almost infinite scope left for investigation of alloy equilibria, especially when more than two metals are involved. A very useful feature is that the compilers have given, where possible, references to Institute of Metals abstracts. This arrangement fails for certain important ferrous systems, where few references are given; here it would surely have been appropriate to cite the abstracts of the Iron and Steel Institute. However, this is a very minor point, and in conclusion one can only admire the compilers' industry and congratulate the Institute of Metals on publishing this valuable work.

A. R. Bailey

Chemistry

The Conquest of Materials. By Kenneth Hutton. (Pelican Book No. A353.) Pp. xii + 228 + 26 plates. (Harmondsworth, Mddx.: Penguin Books, Ltd., 1957.) 3*s*. 6*d*.

THIS book is divided into two parts, the first of which (58 pages) is devoted to pure chemistry. Holding the view that the layman likes to know something about this aspect of the science, the author goes into it sufficiently for that class of reader to grasp the meaning of such fundamental terms as element, compound, acid, base and salt. In addition, he tackles formulæ and equations, the atomic theory and the periodic system. The molecular structures appearing in this section and the numerous ones given in Part 2 will doubtless please the school pupil but puzzle the layman. The second part of the book deals with the occurrence, manufacture, properties, and the economic and industrial uses of materials, especially those which are the product of modern synthesis. Among these are foods, fuels, fibres, drugs, detergents, explosives, plastics, silicones, spermicides, vitamins and weed-killers. Dispersed through the text are the names of books going deeper into the subject in question. The illustrations consist of twenty-six half-tone plates and thirty-two figures; there are also eleven tables.

The author writes in a pleasing, conversational style and seasons his descriptions with a delightful humour. Whether expatiating on salvarsan, electricity versus coal, 'Terylene' ties and socks, or the hazard of putting an alcoholic under an anæsthetic, he is always accurate and informative. With the knowledge gained from his extensive reading, his visits to industrial works, his experience as a chemistry master and from his life at home, he has punctuated his descriptions with comments and arresting sidelights so that almost every page is replete with interesting information. Indeed, the book contains a wealth of valuable matter attractively presented. Dr. Hutton has made a great effort to explain the triumphs and the great possibilities of chemistry to the intelligent but non-scientific reader, and it has been a pleasure to review his book.

G. Fowles

Organic Chemistry

By Louis F. Fieser and Mary Fieser. Third edition. Pp. v+1112. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1956.) 60*s*. net.

SINCE the second edition of this well-known textbook was published in 1949 there have been important advances both in experimental and theoretical organic chemistry. These have been adequately incorporated in this completely revised edition. In theory, conformational analysis, molecular orbital theory and reaction mechanisms have been treated. The elementary discussions of wave mechanics and its relations to valency theory are appropriate in a book on organic chemistry, since the full treatment will usually come in later courses in physical chemistry and the student of elementary organic chemistry needs to know something of them before this. On the factual side the book is unusually complete, with an emphasis on biochemistry which makes it especially valuable. The general treatment of classical organic chemistry is very sound, preparative methods and group reactions not being sacrificed to undue emphasis on reaction mechanisms, although these have their place. Interest is added by brief biographical sketches of past and present organic chemists; the authors say that there are 454 of these. All the formulæ are clearly set out, and the illustrations of apparatus are unusually attractive. There can scarcely be any other book covering such a wide range as this and so up to date. The concise and clear style has enabled the authors to present an astonishing amount of information in a book of reasonable size.

J. R. Partington

Heterocyclic Compounds

Edited by Robert C. Elderfield. Vol. 5: Five-Membered Heterocycles containing Two Hetero Atoms and Their Benzo Derivatives. Pp. vii+744. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 160*s*. net.

THE fifth volume of this useful series deals with five-membered heterocyclic systems containing two heteroatoms, that is, 1:3-dioxolanes, pyrazoles, indazoles, imidazoles, oxazoles, benzoxazoles, isoxazoles, thiazoles and benzothiazoles. The presentation follows that established by the previous volumes; general methods of synthesis of each class are followed by a discussion of the properties and reactions pertaining thereto. This complex mass of information is methodically and clearly laid out and, although each chapter has different authorship, a pleasingly uniform presentation has been achieved. These volumes are proving most useful in filling the hitherto large gap in the systematic text-book literature of heterocyclic chemistry, although the price will no doubt deter some prospective buyers.

R. A. Raphael

AN EXPERIMENT ON AIR SHOWERS PRODUCED BY HIGH-ENERGY COSMIC RAYS

By Drs. G. CLARK, J. EARL, W. KRAUSHAAR, J. LINSLEY, B. ROSSI and F. SCHERB

Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts

PROBLEMS of interest to both the physicist and the astrophysicist single out the high-energy component of cosmic rays as a particularly promising subject of research. On one hand, the shape of the spectrum and the directional distribution of the incoming particles depend critically on the structure of the galaxy and on the mechanism responsible for the acceleration of cosmic rays. On the other hand, despite the remarkable progress of accelerators, we still have to turn to cosmic rays in order to obtain information on the fundamental problem of nuclear interactions at energies which, in the centre of mass of the colliding particles, are greatly in excess of the rest-energy of nucleons.

The cosmic-ray spectrum falls off rapidly with increasing energy. Thus particles of very high energies are exceedingly rare; for example, the rate of arrival of particles with more than 10^{16} eV. energy is of the order of one per year per square metre. Hence direct methods of detection are ruled out, and the only practical approach is the study of the giant showers that are produced in the atmosphere by high-energy cosmic-ray particles.

The essential features of this phenomenon are well known. After a comparatively short path through air, the primary particle collides against an atomic nucleus, producing a number of high-energy secondary particles. Among these are π^0-mesons, which immediately decay into photons, and nuclear-active particles (charged π-mesons, nucleons, etc.), which go on to produce further interactions, so that a nuclear cascade develops. At each step a certain fraction of the energy goes into photons via the decay of π^0-mesons; photons initiate electronic cascades and soon electrons and photons become the dominant component of the shower. Some of the charged π-mesons, however, decay before interacting and thus contribute an appreciable number of μ-mesons to the shower. Scattering in air spreads the shower particles over a wide area, with a density that decreases gradually as the distance from the shower core increases.

Our group has been operating, intermittently since July 1955, and continuously since June 1956, an experiment on large air showers. Unlike previous experiments of a similar nature, our experiment is designed to provide sufficient information on each individual shower to determine accurately the size of the shower and the direction of arrival of the initiating particle.

We use as detectors plastic scintillators in the shape of disks 105 cm. in diameter and 10 cm. thick. Each scintillator is viewed by a single Dumont 5-in. photo-tube. The detectors are arranged in a circular area of about 460 m. in diameter, in the grounds of the Agassiz Astronomical Station of Harvard University at Cambridge, Massachusetts, 183 m. above sea-level (Fig. 1). For most of the time we have used eleven

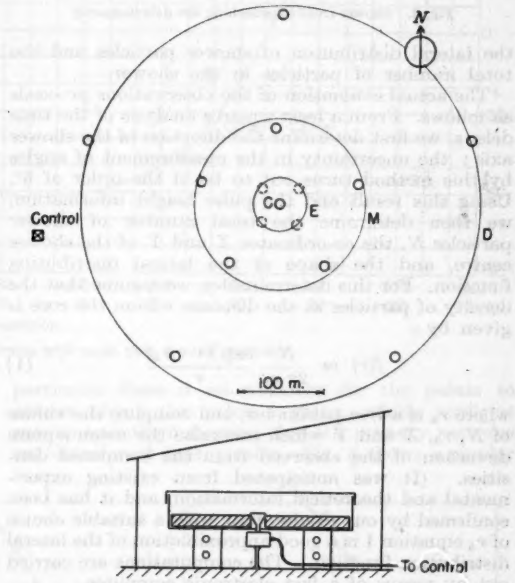


Fig. 1. Detector array and schematic diagram of a scintillation counter

detectors (C, M and D in Fig. 1), but during a short period we had four additional detectors placed near the centre of the array (E in Fig. 1) in order to extend our measurements to showers of smaller size than those which could be recorded in the main experiment. The detectors are connected by cables to separate oscilloscopes, which are situated in a control station and arranged one next to the other so that they can be photographed by a single camera. The sweeps of the oscilloscopes are triggered simultaneously whenever ten or more shower-particles traverse each of at least three among a pre-selected group of detectors, within a time interval of about 3 microseconds.

From preliminary experiments conducted at our laboratory[1], it is known that at any one instant of time practically all shower particles lie within a disk of only a few feet in thickness, perpendicular to the direction of propagation of the shower, that is, to the direction of arrival of the initiating particle. Fig. 2 shows schematically a shower front approaching the counter-array, and illustrates the principle of our method. It is clear that the differences between the times of arrival of the shower front at the various detectors depend on the direction of the shower axis, whereas the pulse heights (which are proportional to the numbers of shower particles traversing the detectors) depend on the location of the shower core,

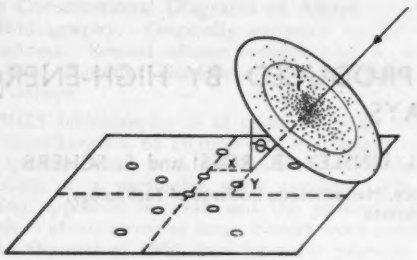


Fig. 2. Shower front approaching the detector array

the lateral distribution of shower particles and the total number of particles in the shower.

The actual evaluation of the observations proceeds as follows. From a least-squares analysis of the time delays, we first determine the direction of the shower axis; the uncertainty in the measurement of angles by this method turns out to be of the order of 5°. Using this result and the pulse height information, we then determine the total number of shower particles N, the co-ordinates X and Y of the shower centre, and the shape of the lateral distribution function. For this determination we assume that the density of particles at the distance r from the core is given by:

$$f(r) = \frac{N}{2\pi r_0} \frac{\exp(-r/r_0)}{r} \qquad (1)$$

where r_0 is a free parameter, and compute the values of N, r_0, X and Y which minimize the mean square deviation of the observed from the computed densities. (It was anticipated from existing experimental and theoretical information, and it has been confirmed by our results, that with a suitable choice of r_0 equation 1 is a good approximation of the lateral distribution function.) The computations are carried out by means of a fast electronic computer.

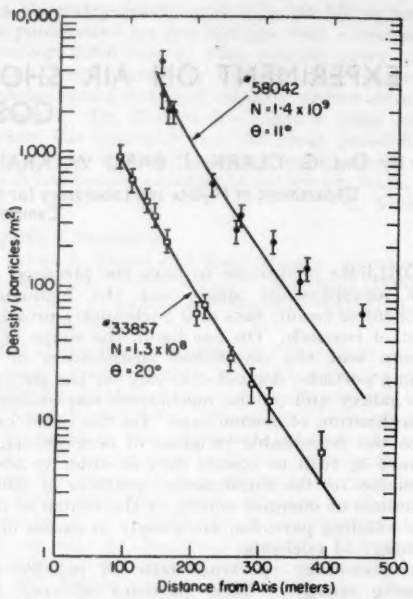


Fig. 3. Lateral density distributions of two large showers

We calibrate the detectors by measuring the distribution in height of pulses produced by single cosmic-ray particles. The overall performance of the equipment is periodically checked by an automatic device which, every 7 hr., plots the bias curve of each detector. In addition, the counting rates of all detectors for pulses greater than those corresponding to the passage of 10 particles are continuously recorded. In what follows we give a preliminary account of the results obtained to date.

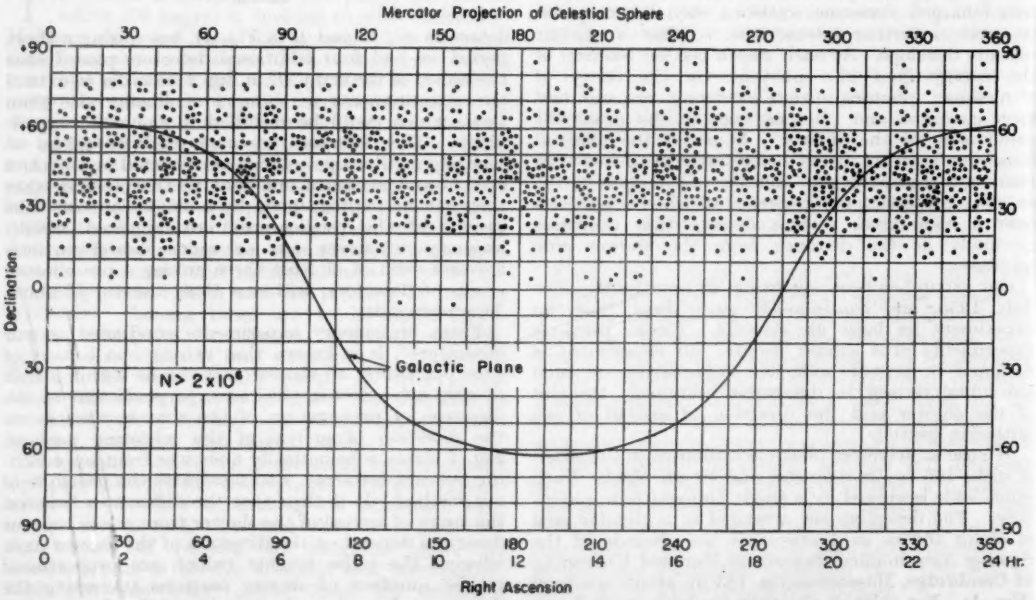


Fig. 4. Directions of arrival of 1,286 showers with more than 2×10^8 particles

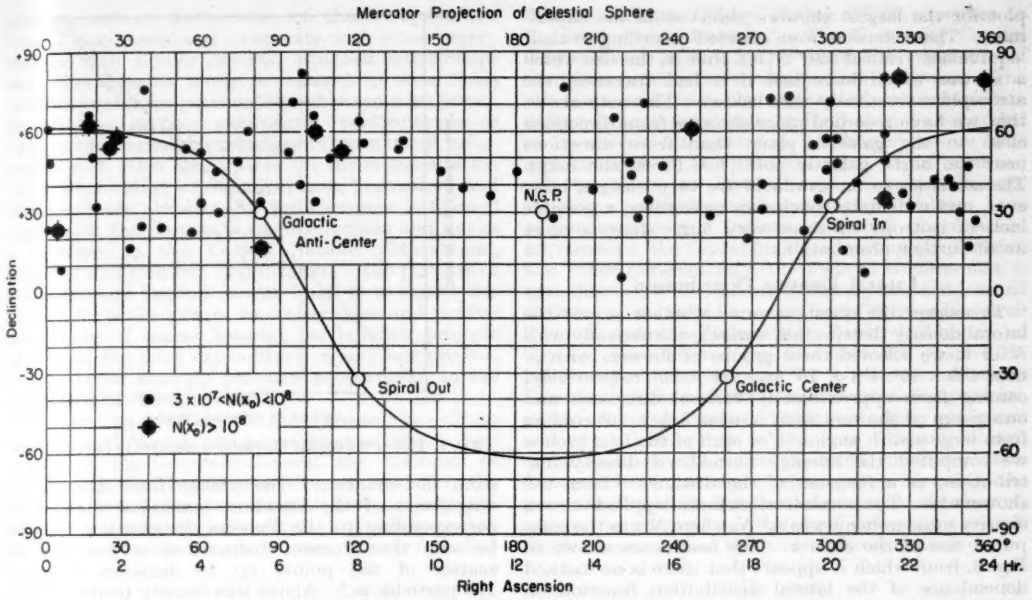


Fig. 5. Directions of arrival of 87 showers with more than 3×10^7 particles

Largest Recorded Shower

Showers with more than 10^8 particles are recorded by our array at the rate of about one per month. Showers of comparable size are currently recorded by the Harwell group with an array of Geiger counters covering an area of 0·47 km.² (W. Galbraith, private communication). The largest shower recorded so far had $1{\cdot}4 \times 10^9$ particles and came at a zenith angle of 11°. The energy of the primary particle responsible for this shower was probably close to 10^{19} eV. and could not have been smaller than 2×10^{18} eV., even allowing for a large fluctuation in the longitudinal development of the shower. The lateral density distributions for this shower and for another large shower are shown in Fig. 3.

Distribution in the Directions of Arrival

Fig. 4 summarizes the results obtained so far for showers with more than 2×10^8 particles. Each point represents the direction of arrival of an individual shower, on a Mercator projection of the celestial sphere. Atmospheric absorption is responsible for the fact that the experimental points lie within a narrow band of latitude, centred at 42° (the latitude of our station). Along this band there is no significant variation in the density of points, and in particular there is no tendency for the points to cluster about the galactic plane, which confirms previous results indicating that the primary particles are distributed isotropically. Fig. 5 shows a similar

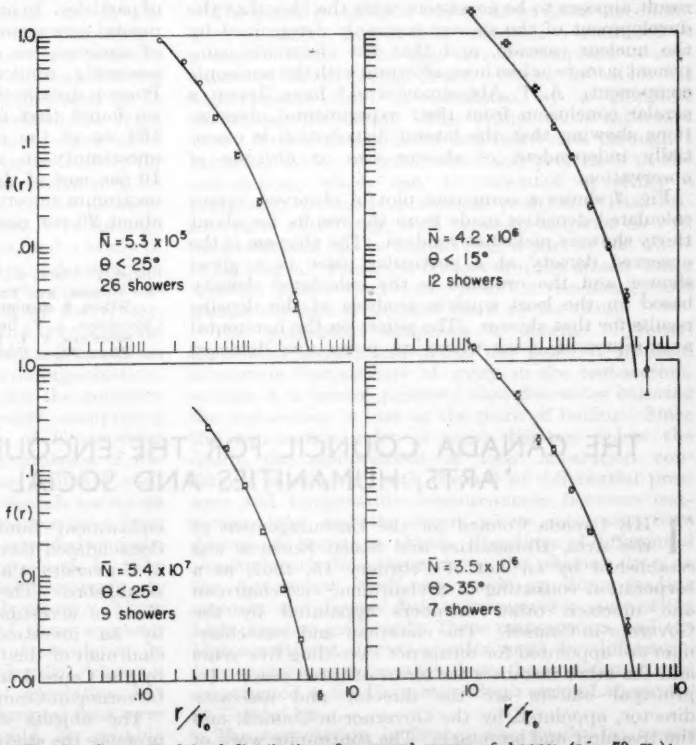


Fig. 6. Composite lateral distributions for several groups of showers (r_0 = 79 m.); the curves represent $f(r)$ defined by equation 1

plot for the largest showers observed in the experiment. These showers were selected according to their 'equivalent vertical size' $N(x_0)$, that is, the size which a shower would have had if it had traversed the atmosphere vertically (see below). The map shows that we have recorded more showers from directions close to the galactic plane than from directions near the north galactic pole (N.G.P. on the map). The statistics so far available are very meagre, however, and a definite conclusion concerning a possible lack of isotropy of these very large showers must await further observations.

Lateral Density Distribution

To answer the question as to whether or not the lateral density distribution varies systematically with N or θ, we selected three groups of showers with N near $4{\cdot}5 \times 10^6$, $4{\cdot}2 \times 10^6$ and $5{\cdot}4 \times 10^7$, respectively, coming from approximately vertical directions and one group of showers with N near $3{\cdot}5 \times 10^6$ coming from large zenith angles. For each of the four groups we computed the average normalized density distribution, as a function of the distance r from the shower axis. The normalization factor applied to each density measurement was r_0^2/N, where N was the computed size of the shower. The results are shown in Fig. 6, from which it appears that there is no marked dependence of the lateral distribution function on either the size N or the zenith angle θ. In all cases the experimental distribution agrees with that given by equation 1 with $r_0 = 79$ m. This distribution, incidentally, is practically identical (up to about 300 m.) with that given by the theory of Nishimura and Kamata[2] for an 'age parameter' $s = 1{\cdot}4$. This result appears to be consistent with the idea that the development of the shower is mainly determined by the nuclear cascade, and that the electronic component is more or less in equilibrium with the nucleonic component. A. T. Abrosimov *et al.*[3] have drawn a similar conclusion from their experimental observations showing that the lateral distribution is essentially independent of shower size or altitude of observation.

Fig. 7 shows a composite plot of observed versus calculated densities made from the results for about thirty showers picked at random. The abscissa is the observed density at a particular place in a given shower and the ordinate is the calculated density based on the least squares analysis of the density results for that shower. (The points on the horizontal axis represent cases where no pulse was detected from the counter.) The broken lines indicate the magnitude of the standard statistical fluctuations corresponding to the Poisson distribution. It can be seen that Poisson fluctuations account for the scatter of the points up to densities of about 100 particles/m.^{2}. Above this density (corresponding to a Poisson fluctuation of 10 per cent) the instrumental errors are the most important source of scatter. Abnormal showers do not appear more frequently than about one per hundred. This means that for most showers we can accurately determine both the position of the centre and the total number of particles. In order to test the response of the experimental arrangement and the accuracy of the method of analysis, we analysed several 'artificial' showers assuming random-density fluctuations obeying a Poisson distribution. From the results of these tests, we found that for showers with cores lying within 160 m. of the centre of the array, the maximum uncertainty in the location of the core is about 10 per cent of the distance from the centre, and the maximum uncertainty in the determination of N is about 20 per cent.

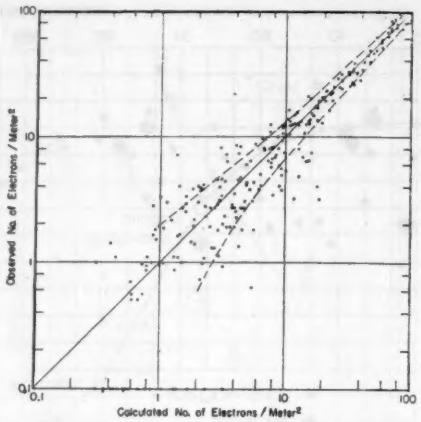


Fig. 7. Plot of the density fluctuations observed in thirty showers

(To be continued)

[1] Bassi, P., Clark, G., and Rossi, B., *Phys. Rev.*, **92**, 441 (1953).
[2] See Greisen, K., "Progress in Cosmic Ray Physics", edit. by J. G. Wilson, **3**, chapter 1 (North Holland Pub. Co., Amsterdam, 1956).
[3] Abrosimov, A. T., Bedniakov, A. A., Zatsepin, V. I., Nechin, Iv. A., Solov'eva, V. I., Kristiansen, G. B., and Chikin, P. S., *J. Exp. Theor. Phys., USSR*, **29**, 693 (1955).

THE CANADA COUNCIL FOR THE ENCOURAGEMENT OF THE ARTS, HUMANITIES AND SOCIAL SCIENCES

THE Canada Council for the Encouragement of the Arts, Humanities and Social Sciences was established by an Act of February 15, 1957, as a corporation consisting of a chairman, vice-chairman and nineteen other members appointed by the Governor-in-Council. The chairman and vice-chairman are appointed for terms not exceeding five years and the other members for terms of three years. Its principal officers are the director and associate director, appointed by the Governor-in-Council, and the treasurer and secretary. The continuing work of the Council is financed by income from a permanent endowment fund of 50 million dollars from the Consolidated Revenue Fund. From the same source a University Capital Grants Fund has also been established. The Council is advised in the management of investments under the Canada Council Act by an investment committee consisting of the chairman of the Council, another member designated by the Council and three members appointed by the Governor-in-Council.

The objects of the Council are to foster and promote the study and enjoyment of, and the production of works in, the arts, humanities and social

sciences, and in furtherance of these objects the Council may assist and co-operate with other organizations with similar objects, establish scholarships and fellowships for study or research in these fields or make awards for outstanding achievements therein. It can also sponsor exhibitions, performances or publications, arrange exchanges of persons or information with other countries or for the representation and interpretation of Canadian arts, humanities and social sciences abroad, and the Governor-in-Council may assign the Canada Council functions and duties in relation to the United Nations Educational, Scientific and Cultural Organization. The purpose of the University Capital Grants Fund is to enable the Council to make grants to universities and similar institutions of higher learning for building projects up to half the total expenditure on any one project, to a total for any one province proportional to the population of that province.

At the first meeting of the Canada Council on April 30 and May 1, the proceedings of which were opened by the Governor-General, the chairman of the Council, the Hon. Brooke Claxton, said that the Canada Council has been established to help the advance of the nation in its artistic expression so that they could, in the words of one of its founding fathers, Thomas D'Arcy McGee, "Lift ourselves to the level of our destinies". The University Capital Grants Fund is intended to assist the expansion of Canadian universities over the next ten years. The chairman said that the income of some 2 million dollars from the endowment fund is to be expended in no narrow interpretation of the expression 'arts and humanities', and that the term 'social sciences' will be taken to include economics, psychology, sociology, political science, geography and law. It is a new venture for Canada, although on research, scholarships, the Canadian Broadcasting Corporation and other organizations, the Federal Government is spending nearly 60 million dollars a year, and learned societies, such as the Canadian Social Science Research Council and the Humanities Research Council of Canada, have been doing fine work for years. He believes the initial tasks will be to discover and assist Canadian artists and thinkers of outstanding promise, and to encourage, train and assist university professors and other instructors in the arts, humanities and social sciences. The vice-chairman, the Very Rev. Georges-Henri Lévesque, also spoke, stressing the pre-eminence of the intellectual concepts and the arts among the cultural and spiritual values of a people for the expression of the soul of the community.

FLOW OF STEAM–WATER MIXTURES AT HIGH PRESSURES

By R. W. HAYWOOD

Engineering Laboratory, University of Cambridge

IN a research project being carried out in the University Engineering Department at Cambridge, a study is being made of the pressure drop and the flow conditions of a steam–water mixture flowing along heated and unheated pipes at pressures up to the critical region. This is a field in which few exact experimental data are available, and which is of importance in the design of high-pressure boilers for power stations and evaporative heat exchangers for nuclear power plant. A knowledge of the pressure drop is essential in estimating the flow-rates through the individual tube circuits of a boiler, and a study of the flow conditions will enable a better understanding to be obtained of the fundamental mechanism of two-phase flow. The project is sponsored by the Water-Tube Boilermakers' Association, and provides an interesting example of close co-operation between an academic body and a commercial trade organization. Not only is the work carried out under the guidance of a joint technical advisory panel comprising representatives of the Department of Engineering at Cambridge and of the member companies of the Association but, in addition to the graduate staff working on the project, numerous research assistants from the staffs of the member companies have been seconded to work at Cambridge for extended periods.

This experimental work was proposed by the University as an extension to some studies previously carried out in the Engineering Laboratory. These studies[1] resulted in a unification of three existing, but previously conflicting, theories of circulation in water-tube boilers known as the 'hydraulic', 'thermodynamic' and 'expansion' theories of circulation, but it was indicated that further experimental data were required before circulation-rates could be reliably predicted.

The plant is installed out of doors from considerations of safety, but all instrumentation is carried to a control-room. The test circuit comprises a continuously recirculating closed system, in which the high-pressure fluid is circulated by a glandless electromersible pump. This pump draws saturated water from a steam drum and delivers it through a metering orifice, control valve and preheater to the test-section, which can be mounted in either a horizontal, inclined or vertical position. The test-section is 24 ft. long, with pressure tappings at 8-ft. intervals, and can be heated over a part or the whole of its length. From the test-section the steam–water mixture passes to a water-jacketed condenser, and thence through a reheater back to the drum.

The preheater comprises a special 'Pyrobar' immersion heater, and brings the water to its local saturation temperature at entry to the test-section, so that it is known precisely that the water entering the test-section is just on the point of boiling. Since the test-section inlet is some distance below the drum, the achievement of local saturation conditions is achieved with the aid of differential pressure and temperature measurements between test-section inlet and the drum, where saturation conditions are known to obtain. Readings of differential pressure, including those giving the pressure drop on the test-section itself, are made on direct-reading mercury and 'Igema'-fluid manometers in spite of the high pressure employed. These manometers, and the high-sensitivity thermo-couples used for differential temperature measurement, have been designed and constructed in the University Engineering Laboratory at Cambridge.

The test-section is heated electrically by means of low-frequency, three-phase, induction heating

utilizing a special form of water-cooled winding, and employing a coating of copper sprayed on to the thick-walled steel pipe constituting the test-section. The heaters have been designed and constructed in the Laboratory in consultation with the patentees of certain features incorporated in the design. The heaters give a uniform power input over the heated length of the test-section, and by alternative methods of series and parallel connexion of the coils and groups of coils constituting the winding, the total power input may be varied over a considerable range in a number of steps without the use of a voltage regulator. The water-cooling provides a ready means of determining the lost power, the small rise in temperature of the inductor cooling water being measured by triple-point differential thermocouples.

In addition to measurements of drop in pressure, the flow conditions are being studied with the aid of a gamma-ray device supplied on loan by the Atomic Energy Research Establishment at Harwell. In this device, a beam of gamma-rays from a radioactive isotope of cæsium is passed transversely through the pipe at test-section outlet. An ionization chamber placed diametrically opposite the source gives a measure of the emergent radiation, which is a function of the density of the fluid cross-section at the scanning point. With this determination of the apparent density of the fluid and a knowledge of the flow-rate and heat input in the test-section, the respective velocities of the steam and water phases at the scanning point may be estimated, for the steam and water do not generally flow along the pipe as a homogeneous mixture. This information is also necessary for the respective drops in pressure due to acceleration and wall friction in the horizontal pipe to be separately estimated. Provision is being made for the installation of further scanning points at intermediate positions along the length of the test-section when it is in the vertical position, since density determination is then more important for an analysis of the pressure drop. As there is little space between the induction heating units at these intermediate points, small ionization chambers, filled with argon under pressure, are being developed to provide higher sensitivity.

Tests have been completed with a test pipe of 1 in. bore in the horizontal position. These tests have been made at varying flow-rates and heat inputs, and at pressures of 250, 600, 1,250, 2,100 and 3,000 lb. in.$^{-2}$. The results of these tests, together with those obtained with other pipe sizes at various inclinations, will be published in due course. Preparations are at present being made for tests on the 1-in. pipe in the vertical position.

[1] Haywood, R. W., "Research into the Fundamentals of Boiler Circulation Theory", Proceedings of the General Discussion on Heat Transfer, September 1951, p. 63 (Institution of Mechanical Engineers and American Society of Mechanical Engineers, 1951).

HAZARDS ASSOCIATED WITH THE DEVELOPMENT OF WEAPONS OF MASS DESTRUCTION

INTERNATIONAL MEETING OF SCIENTISTS

TWO years ago a statement, referred to as the 'Russell–Einstein Appeal', was issued under the signatures of its sponsors and eight other scientists, directing attention to the hazards which would face humanity should another world war break out, a war in which the widespread use of nuclear weapons would be almost certain. The appeal suggested that a meeting of competent scientists ought to take place, to make a true and independent assessment of the dangers.

Through the initiative of Lord Russell and the generous hospitality of Mr. Cyrus Eaton, such a meeting was held in the fishing village of Pugwash, Nova Scotia, during July 6–11. About forty invitations were issued, so chosen as to ensure that the composition of the Conference would be representative of a wide range of opinion on social, economic and political matters, with members competent in the scientific disciplines relevant to the discussion. Twenty-two scientists were able to accept the invitation, and at the end of the meeting a statement was issued, the substance of which is as follows.

In a brief preamble an outline is given of the background to the meeting, and a summary of the most important developments since the original Russell–Einstein appeal was issued. The statement continues: "The general belief that a full-scale nuclear war would bring universal disaster upon mankind, and the recognition that it is technically possible for both the two great contending groups of powers to visit any desired degree of destruction upon an enemy, as well as certain political developments, have created an atmosphere in which it was possible for us to meet, and to discuss dispassionately, many important and highly controversial issues".

The main work of the meeting was centred around three principal topics: (1) the hazards arising from the use of atomic energy in peace and war; (2) problems of the control of nuclear weapons; and (3) the social responsibility of scientists. Three committees were established to give detailed consideration to these topics. In presenting the findings, the signatories remark that the international problems which have arisen with the development of atomic energy are of two kinds—technical and political. Men of science can discuss with special competence only the scientific and technical implications of atomic energy; but their discussions can only be fruitful if they take account of the political problems which form the background to international negotiations. In formulating their conclusions, they state that they have attempted to avoid any exacerbation of the differences between the Powers which might follow, for example, from emphasis on technical considerations unwelcome to one or another of the two groups of Powers.

The committee on the hazards associated with the application of atomic energy found that estimates of the effect of 'fall-out', carried out independently in Great Britain, Japan, the United States and the U.S.S.R., were in good agreement; it reached the conclusion that the dangers from the test explosions carried out hitherto are small compared with those to which mankind is subject from natural causes.

Nevertheless, because of the world-wide distribution of fission products, and the fact that some areas may be subject to effects much above the average, close attention to the dangers should be maintained, especially if tests of bombs which give large radioactive 'fall-out' continue to be made.

The studies of the hazards of test explosions permitted a closer examination to be made of the probable consequences of an unrestricted war with nuclear weapons; this led to the unquestioned conclusion that such a war would represent a disaster of unprecedented magnitude. "In the combatant countries, hundreds of millions of people would be killed outright, by blast, heat and ionizing radiations, at the instant of the explosion, whether the so-called 'clean' or 'dirty' bombs were employed." If 'dirty' bombs were employed, "additional hundreds of millions would die from the delayed effects of radiation from local 'fall-out'—some from direct radiation injury, and some in later generations from genetic effects". Large-scale genetic injury might also follow from global 'fall-out'.

The committee which considered problems of control reached the conclusion that the principal objective of all nations must be the elimination of war, and the threat of war, from the life of mankind. For this purpose, it is necessary to reduce tension among the nations; to promote mutual understanding among the peoples; to strive for the ending of the arms race; and to provide an adequate control system so as to give substantial protection, and permit the development of mutual confidence. "It is unrealistic to depend upon any sudden increase in mutual confidence; it is more likely to grow from small beginnings. In this situation, even small agreements covering limited fields could be of great importance."

The committee which discussed the responsibilities of scientists in the modern world summarized its findings under eleven headings. Among many points of importance, two deserve particular attention: Point 9 states that "Tradition tends to place the emphasis in the education of youth on separate ideals of single nations, including the glorification of war. The atomic age urgently requires a modification of these traditions. Without abandoning loyalty to the national heritage, or to the fundamental principles of the different societies, education must emphasize the fundamental and permanent community of the interests of mankind, in peace and co-operation, irrespective of national boundaries and differences in economic or political systems"; and Point 11, "Science develops most effectively when it is free from interference by any dogma imposed from the outside, and permitted to question all postulates, including its own. Without this freedom of scientific thought, and the freedom to exchange information and ideas, full utilization of the constructive possibilities of science will not be possible".

The conference was unique in that never before had a group of scientists, so widely representative, met to discuss topics of such general importance. It is remarkable that it was possible to issue a statement, with such a measure of agreement, on many issues which might have appeared highly controversial and unlikely to receive general support. The statement concludes by giving expression to the unanimity in the conference on fundamental aims: "We are all convinced that mankind must abolish war or suffer catastrophe; that the dilemma of opposing power groups and the arms race must be broken; and that the establishment of lasting peace will mark the opening of a new and triumphant epoch for the whole of mankind. We earnestly hope that our conference may make a modest contribution to these great aims".

The signatories were: *Australia*, Prof. M. L. E. Oliphant; *Austria*, Prof. H. Thirring; *Canada*, Dr. G. Brock Chisholm; *China*, Prof. Chou Pei Yuan; *France*, Prof. A. M. B. Lacassagne; *Great Britain*, Prof. C. F. Powell, Prof. J. Rotblat; *Japan*, Prof. I. Ogawa, Prof. H. Yukawa, Prof. S. Tomonaga; *Poland*, Prof. M. Danysz; *U.S.A.*, Prof. D. F. Cavers, Prof. H. J. Muller, Prof. P. Doty, Prof. E. Rabinowitch, Prof. W. Selove, Prof. V. Weisskopf; *U.S.S.R.*, Academician A. M. Kuzin, Academician D. F. Skobeltzyn, Academician A. V. Topchiev.

OBITUARY

Mr. R. G. K. Lempfert

METEOROLOGISTS learned with great regret of the sudden death on June 24 of R. G. K. Lempfert, formerly assistant director of the Meteorological Office. Sir Napier Shaw recorded that when he became the effective head of the Meteorological Office nearly sixty years ago, one of its peculiarities was that none of the members of the staff had had any preliminary scientific training. (This does not mean that they lacked ability—far from it. For example, out of a small staff one became Mayor of Camberwell and another Mayor of Fulham.) Shaw's first step to remedy the obvious defect was to appoint Lempfert, who had taken a 'first' at Cambridge in both parts of the Natural Science Tripos, in 1896 and 1898, to a specially created post of scientific assistant. Not surprisingly, this appointment in 1902 has been abundantly justified both by the investigations Lempfert undertook or shared and by the influence he exerted on meteorological administration and operational meteorology for a quarter of a century.

Lempfert's scientific investigations covered a wide field. Many were made in collaboration with others. He began with studies of London fog and of a fall of 'red rain', found to be due to dust the track of which was traced back around the Iberian peninsula to North Africa. Soon he was tackling, with Shaw, the "Life History of Surface Air Currents". Lempfert's part was mainly the critical examination and co-ordination of the records and observations from which the divergent sources and tracks of the air in a number of typical or outstanding meteorological situations could be identified and delineated. But he also made a separate special study of the line-squall, one of the most significant and qualitatively foreseeable meteorological phenomena—the simultaneous occurrence of squalls, sometimes of great violence, along a line which may be hundreds of miles long and which may advance at 5 or at 50 miles per hour. These investigations, revealing as they did unsuspected discontinuities in the earlier simplified structure of 'depressions', paved the way for the

Norwegian development of frontal meteorology, the dominating influence on macro-meteorology in the period between the two World Wars. In fact, the first use of the word 'front' in its present technical sense appears to have been in the second paper on line-squalls (Lempfert and Corless, 1910).

The expansion of the Meteorological Office during and after the First World War and its transference to the Air Ministry involved Lempfert in much administrative work, but he maintained a lively interest in the scientific work both of the Meteorological Office and of the Royal Meteorological Society, of which he was president during 1930–32 and the *Journal* of which he edited for many years.

After his retirement in 1938 he was responsible, as an executor of Sir Napier Shaw's will, for the establishment of the Napier Shaw Meteorological Library in the Cavendish Laboratory at Cambridge; and for the selection and publication in one volume of the "Selected Meteorological Papers of Sir Napier Shaw". This included the "Life History of Surface Air Currents", which had long been out of print. It was a classic, essential to a meteorological library, and many such libraries had been unable to get a copy.

Lempfert was born in Manchester on October 7, 1875, the son of R. B. and Olga (née von Pein) Lempfert. They were both musical and Lempfert's recreation was music; an incident illustrates his love of it. He was the first to give a course of meteorological lectures for airmen—at the Central Flying School, Upavon, when Trenchard was commandant. The honorarium, less the cost of a dinner to celebrate with his friends the successful conclusion of the course, was spent in the purchase of a rare violin. A few years later he married, in 1916, a distinguished violinist, Marjorie Hayward. She predeceased him. Lempfert was practically bilingual, speaking English and German with equal facility, a great asset at international meetings, where he was held, rightly, in the highest esteem. In the Meteorological Office his courtesy was proverbial; loyalty and unselfishness were, with him, innate qualities. E. Gold

NEWS and VIEWS

Mount Wilson and Palomar Observatories: Dr. S. B. Nicholson

Dr. Seth B. Nicholson, of the Mount Wilson and Palomar Observatories, retired on July 1. He obtained his Ph.D. from the University of California in 1915 and in the same year joined the staff of the Mount Wilson Observatory, where he investigated the orbits of several of Jupiter's satellites, the ninth of which he had discovered at the Lick Observatory in 1914. In collaboration with Dr. Edison Pettit, he developed a very sensitive vacuum thermocouple, which they used for measuring the total radiation and surface temperatures of stars, planets and the Moon. Studies of the rate of cooling of the Moon's surface during an eclipse demonstrated its low conductivity; their results suggest the presence of a layer of dust and the absence of an atmosphere, in agreement with optical and radio observations. In the late 1930's, and again in the early 1950's, Dr. Nicholson returned to the observation of Jupiter's satellites; he discovered the tenth, eleventh and twelfth of these and determined the positions necessary to fix their orbits. Dr. Nicholson is also an eminent authority on solar phenomena, and supervised the systematic collection of magnetic and other data on sunspots. He has made detailed studies, in collaboration with Dr. Oliver Wulf, of the California Institute of Technology and the United States Weather Bureau, of solar-terrestrial relations. Dr. Nicholson is a member of the U.S. National Academy of Sciences, the American Astronomical Society and the Astronomical Society of the Pacific.

Dr. M. L. Humason

Dr. Milton L. Humason, secretary of the Mount Wilson and Palomar Observatories since 1948, retired on July 1 after a most remarkable career. He joined the Mount Wilson Observatory in 1917, first as janitor and then as night assistant, and showed such skill as an observer that he was appointed to the staff of investigators in 1922. His unique gift was an unusual proficiency in photographing the spectra of very faint objects. Following the late Dr. Edwin Hubble's discovery in the 1920's of the major part played by the extra-galactic nebulæ in the structure of the universe, Humason turned to the study of these objects and soon accumulated spectra of numerous galaxies at various distances. This material led Hubble to his famous velocity–distance relation and to the observational basis of the concept of the expanding universe. For the following quarter-century, Dr. Humason continued to devote most of his attention to this problem: improvements in photographic emulsions and in spectrograph design, together with the completion of the 200-in. Hale telescope, enabled him to push his observations to much fainter, more distant galaxies, many of them too faint for visual guiding on the spectrograph slit. For these, Dr. Humason had to develop elaborate 'off-set' procedures to keep the invisible images accurately on the slit throughout long exposures. His studies culminated in the publication in 1956, together with Dr. N. Mayall and Dr. Allan Sandage, of the velocities of more than nine hundred galaxies, some being as great as one-fifth the velocity of light. Dr. Humason received his Ph.D., *honoris causa*, from the University of Lund in 1950 and is a member of the American Astronomical Society, the Astronomical Society of the Pacific, and the International Astronomical Union. He was elected an Associate of the Royal Astronomical Society in April 1957.

Chemistry in Manchester: Prof. R. N. Haszeldine

The Councils of the University of Manchester and the Manchester College of Science and Technology have approved the appointment of Dr. R. N. Haszeldine to the chair in chemistry in the Faculty of Technology as from October 1. He succeeds Prof. H. N. Rydon, who is going to the University of Exeter (see *Nature*, April 20, p. 807). Dr. Haszeldine, who is thirty-three years of age, was educated at the Stockport Grammar School, and entered the Univer-

sity of Birmingham with a John Watt Memorial Scholarship in 1942. He graduated with first-class honours in chemistry in 1944, and two years later obtained his Ph.D. In 1947 he went to the University Chemical Laboratory, Cambridge, becoming eventually assistant director of research in organic and inorganic chemistry. He qualified for the degree of D.Sc. (Birmingham) in 1955. Dr. Haszeldine was awarded the Meldola Medal by the Royal Institute of Chemistry in 1953. He is the author or joint author of a very large number of papers arising out of his research work and is joint author with Dr. A. G. Sharpe of "Fluorine and its Compounds" (1951). Outside the laboratory, he has interested himself in the applications of chemistry in industry and has invented several industrial processes.

Capper Pass Awards in Metallurgy

THE adjudicating committee for the Capper Pass awards, representing the Councils of the Institution of Mining and Metallurgy and of the Institute of Metals, has made the following awards in respect of papers published in the *Transactions of the Institute of Mining and Metallurgy* and the *Journal of the Institute of Metals* for the year 1956: £120 to Dr. J. M. Fletcher, Dr. D. F. C. Morris and Mr. A. G. Wain for a paper on "Outline of a Solvent Extraction Process for the Purification of Niobium from Ores or from Ferro-Niobium"; fifty guineas to Mr. J. A. Grainger for a paper on "The Deep Drawing and Spinning of Sheet Metal, with Particular Reference to Non-Ferrous Materials"; fifty guineas to Mr. J. Fielding for a paper on "Rubber Pressing". These awards are made from a fund placed at the disposal of the Councils of the two Societies by the Directors of Capper Pass and Son, Ltd., for the encouragement of the publication of scientific and technical papers dealing with processes and plant used in extraction metallurgy and on the subject of assaying and of papers and processes used in all branches of the non-ferrous metal industry.

Collaboration between Britain and Norway in Atomic Energy Developments

THE United Kingdom Atomic Energy Authority and the Norwegian Institute for Atomic Energy have recently signed an agreement for co-operation in connexion with the Norwegian Halden Reactor Project. This project is concerned with an experimental reactor, scheduled to start operation early in 1958, which is designed to produce process steam suitable for wood-pulp mills and other industrial uses. The United Kingdom Authority has undertaken to supply the initial charge of uranium fuel elements for the reactor. The Norwegian Institute and the Authority will also co-operate in a research programme with the view of developing suitable fuel elements for later charges for the reactor. The agreement provides for the Authority to have access to the reactor design and to the operating experience obtained from this important experiment.

The Meteorological Committee

THE Secretary of State for Air, Mr. George Ward, M.P., announced in the House of Commons on June 28 last that he had accepted a recommendation of the Brabazon Committee that the Meteorological Committee, which was formed in 1919 and included representatives of various departments with a user interest in meteorology, should be replaced by an advisory committee all members of which should be outside the Government Service. The new Committee will keep under review the progress and efficiency of the Meteorological Office and the broad lines of its current and future policy. It is constituted as follows: Lord Hurcomb (*chairman*); Sir Austin Anderson; Sir David Brunt; Sir Charles Normand; Colonel N. V. Stopford Sackville.

Element 102

ELEMENT No. 102, for which the name 'nobellium' has been proposed, was recently synthesized by a joint Swedish, American and British team at the Nobel Institute for Physics in Stockholm (see *Nature*, July 20, p. 120). It has been announced that there will be a special meeting of Section B (Chemistry) of the British Association, on September 9 at 2.30 p.m., when Mr. H. A. C. McKay and Dr. J. Milsted, of the Atomic Energy Research Establishment, Harwell, the latter of whom was a member of the Swedish–American–British team of discoverers of the new element, will describe this work.

Oil Consumption in the United Kingdom

FIGURES recently published by the Petroleum Information Bureau (U.K. Petroleum Industry Statistics relating to Consumption and Refinery Production, 1955 and 1956. Pp. 10. London: Petroleum Information Bureau, 1957) show that, despite petrol rationing and restrictions during the October–December quarter due to the Suez crisis, the oil consumption in Britain for 1956 rose considerably to a total of 25,233,049 tons, representing an increase of 8·5 per cent over the 1955 figure. Fuel oil deliveries, chiefly for central heating and steam raising, showed an increase of nearly 16 per cent compared with the previous year. Gas/diesel oil consumption increased by 10·5 per cent. Motor spirit, at 6,323,654 tons, represents only a 1·3 per cent increase over 1955, and it is interesting to note that in the last quarter restrictions only accounted for a 1·2 per cent fall. The demand for burning oil increased by 20 per cent. All other petroleum products showed increases, with the exception of vaporizing oil which, at 574,175 tons, represented a fall of 16·7 per cent. Motor spirit produced by low-temperature carbonization amounted to 3,633 tons, which is a slight increase over the 1955 figure; motor and aviation spirit produced by hydrogenation, at 84,114 tons, represents a fall by comparison. Refined benzole, at 314,489 tons, is a substantial rise on the 1955 total.

Trade Fairs and Exhibitions

A BROADSHEET on "Trade Fairs and Exhibitions" (No. 411. Pp. 109–140. 3*s*. 6*d*. net), issued by Political and Economic Planning, is concerned with British sales and prestige abroad. After considering briefly in succession international exhibitions (especially the forthcoming Brussels Exhibition, April to October 1958, the total cost of which to Britain is expected to be £1–2 million, including up to £400,000 from the Exchequer), trade fairs and international trade fairs, the broadsheet discusses the problem of selling British goods overseas, before considering, finally, what future British policy should be. The great disadvantage of general fairs for highly industrialized countries is that the range of products is now so great that no general fair, however large, can

show them all. There is a strong case for greater international emphasis in British trade fairs, whether general or specialized. Britain at present is without an up-to-date exhibition centre offering amenities comparable with those available in many European countries. Consideration is now being given to the possibility of the British Industries Fair at Castle Bromwich becoming the first British general international trade fair. However, Political and Economic Planning argues strongly that the London area is in many ways more suitable, and suggests that the Crystal Palace, Olympia and Earls Court sites should be fully considered. It is important that early decisions should be reached on the part which international trade fairs should play in Britain in the future, and the broadsheet suggests also that there is a case for an executive body, representative of both Government and industry, to finance and deal with the difficult question of British pavilions at trade fairs which are organized on the national pavilion pattern.

International Council of Scientific Unions

For all that it represents, the 1957 Year Book of the International Council of Scientific Unions (pp. ii+72. London: International Council of Scientific Unions, 1957) is among the most modest of annual reports. The calendar of meetings for 1957 arranged by the thirteen international scientific unions which make up the International Council alone makes fascinating reading; the truly international nature of the organization is shown by the list of countries belonging to the different scientific unions. Forty-two countries, including the U.S.S.R. and Rumania, belong to the Internationa' Council; even more encouraging is the fact that forty-seven countries, including the People's Republic of China and Hungary, belong to the International Union of Geodesy and Geophysics. The Yearbook also contains a list of all members of commissions and important committees of the different organizations, the text of the agreement between the International Council of Scientific Unions and Unesco and reports on activities during 1955–56.

Conference on Ethology and Comparative Psychology

Between July 9 and August 3, a conference was held at the Center for Advanced Study in the Behavioral Sciences, Stanford, California, the purpose of which was to facilitate the exchange of ideas between representatives of ethology and comparative psychology. No formal programme or agenda was drawn up in advance of the meeting and no 'papers' in the usual sense were presented. Each participant reported results of his more recent investigations. This took approximately two weeks; the second half of the conference was given over to the discussion of general theoretical issues such as the use of formal and physiological genetics in the interpretation of behaviour, the ontogeny of behaviour, the role of physiology in behavioural theory, phylogenetic differences in motivational systems, 'drive' as a hypothetical concept and as an intervening variable, and a number of specialized ethological concepts including those of displacement activities, innate releasing mechanisms and imprinting. Because the conference was planned as an informal, relatively unstructured series of meetings, and because each participant was promised that he would not be required to produce any publishable paper, the results of the conference will not appear in print. However, intangible results were numerous and important, and each contributor felt that his own thinking and research would benefit greatly as a consequence of the discussions. The expenses of the conference were defrayed by the Center. Those taking part were: Gerard Baerends (University of Groningen), Frank Beach (Yale University), Harry Harlow (University of Wisconsin), Donald Hebb (McGill University), Eckard Hess (University of Chicago), Robert Hinde (University of Cambridge), Jan van Iersel (University of Leyden), Daniel Lehrman (Rutgers University), Jay Rosenblatt (American Museum of Natural History), Niko Tinbergen (University of Oxford) and David Vowles (University of Reading).

Fungal Saccharification of Potato Mashes

Semi-pilot plant experiments on the saccharification of potato mashes by means of fungal preparations are described by K. Beran, M. Burger and S. Zelenka in *Folia Biologica* (3, 89; 1957), the journal of the Academia Scientiarum Bohemoslovenica. The saccharification was effected by using a combination of preparations of *Aspergillus niger* and *A. oryzae* and of *A. niger* alone. No special technological difficulties were met, and it was not necessary to add malt to the mash. The mashes saccharified by the fungal preparations were more fluid than those saccharified with malt. Liquefaction was normal when *A. niger* alone was used. The yield of alcohol from mashes saccharified with the fungal preparations was greater than from mashes saccharified with malt and was increased still further by using a suitable strain of yeast. When using a preparation of *A. niger*, the higher saccharification temperature (65° C.) and the lower *p*H (4·5–5·0) prevented the development of infection, both during saccharification and also, as regards the *p*H, during fermentation. The quality of the crude alcohol obtained was the same, whether fungus or malt was used. As a result of the saccharification activity of preparations of *A. oryzae*, galactose was released during fermentation.

Visual Deficiency Symptoms in Rubber

E. W. Bolle-Jones has made a useful contribution to our knowledge of the visual symptoms in *Hevea brasiliensis* of deficiencies in macro- and micronutrients (*J. Rubber Res. Inst. Malaya*, 14, 493; 1956). These symptoms, which are briefly described in the text and are excellently illustrated in colour and by photographs, were obtained in seedlings grown in pot sand culture. Many of the deficiencies described, for example, those of copper, have not been encountered in the field, but others, for example, of magnesium, are of common occurrence. As the author implies, the whole question of deficiency symptoms is one that needs to be approached with some caution; but work of the kind now under consideration has done much to clarify the situation. Thus, whereas the symptoms of magnesium deficiency are so diagnostic as not to need confirmation by chemical analysis, those due to shortage of calcium are ill-defined and call for supporting analytical evidence. The materials used were seedlings of clone *Tjir* 1 or clone *PB* 86. Deficiency symptoms now illustrated and described, but not previously published, include those of calcium, boron, copper, zinc and, in part, sulphur.

Molybdenum Nutrition and Free Amino-Acids in Tomato

J. V. POSSINGHAM has obtained some interesting results in an investigation of the effect of molybdenum on the content of free amino-acids and amides in tomato plants (*Austral. J. Biol. Sci.*, 10, 40; 1957). The plants, which had been cultured in the absence of molybdenum, were provided with molybdate, and the consequent changes in the relative amounts of the free amino-acids and amides were followed over an experimental period of four days. Quantitative paper chromatography was used for estimating the individual free amino-acids and amides, the results being expressed on a dry-weight basis. Changes in the concentrations of many of the individual amino-acids occurred within four hours of applying molybdenum. Large increases in the concentration of aspartic acid, glutamic acid, glycine, glutamine and asparagine occurred initially with molybdenum treatment, but were followed by steady declines. A different pattern of change was shown by the two compounds β-alanine and γ-aminobutyric acid, both of which decreased in concentration soon after molybdenum was applied. The results of this investigation are discussed in relation to the pathway by which the products of nitrate reduction are incorporated into proteins.

Mathematical Colloquium at University College, Cork

ABOUT thirty delegates from Irish universities, the Dublin Institute for Advanced Studies and the Irish Civil Service attended a mathematical colloquium at University College, Cork, during July 10–12. Profs. M. H. A. Newman and G. Temple gave short courses of lectures on mathematical logic and the theory of distributions, and splinter groups in algebra, analysis and applied mathematics were also organized. It is hoped to arrange an Irish mathematical colloquium at regular intervals in future. Inquiries should be addressed to the Organizing Secretary, Cork Mathematical Colloquium, Department of Mathematical Physics, University College, Cork.

Forestry and the United Nations

AN interesting and informative article on the forest work of the Food and Agriculture Organization of the United Nations by Sir H. Beresford Pierce appears in *Forestry* (30, No. 1; 1957. Oxford University Press). Forestry is one side only of the work of the Food and Agriculture Organization, which has five divisions—agriculture, economics, nutrition, forestry and fisheries. The forestry work is of a world-wide order, so as to reach backward countries where the aims and objects of scientific forestry are unknown or neglected. The Organization keeps in touch with the needs and wishes of governments all over the world through a number of regional Commissions, including the European Forestry Commission based on Rome, the Near East Commission based on Cairo, the Latin American Commission based on Rio de Janeiro and the Asian Pacific Forestry Commission based on Bangkok. Because of its special problems there is also a sub-Commission for the Mediterranean area. There is no commission as yet for North America, nor for West Africa south of the Sahara, although the latter is a region where there is much to be done in the forestry line.

A World Forest Inventory, which has been one of the objects of the forestry work of the United Nations, was first completed in 1948; the second, an appreciably better assessment, appeared in 1953; and a third is planned for 1958.

Announcements

DR. RICHARD E. SHOPE, of the Rockefeller Institute, has been awarded the George M. Kober Medal of the Association of American Physicians for his work on the occurrence of animal viruses.

PROF. W. E. MORTON, professor of textile technology in the University of Manchester, has been awarded the Warner Memorial Medal for 1957 of the Textile Institute. The Warner Medal is awarded in recognition of outstanding work in textile science and technology, the results of which have been published, and particularly for work published in the *Journal of the Textile Institute*.

PROF. R. CRUICKSHANK, principal of the Wright–Fleming Institute of Microbiology, St. Mary's Hospital Medical School, London, has been appointed professor of bacteriology in the University of Edinburgh.

A GENERAL meeting of the Association of Applied Biologists will be held in the University of Leeds during September 19–20. Particulars can be obtained from Dr. J. H. Western, Department of Agriculture, The University, Leeds 2.

THE next meeting of the Photoelectric Spectrometry Group will be the ninth annual general meeting and will take the form of a joint meeting with the Photobiology Group to be held in the Old Medical School, University of Liverpool, on September 26. The subject of the meeting will be "The Spectroscopy of the Natural Pigments". The Photobiology Group will also meet on the following day. Details can be obtained from the Honorary Secretary, Photoelectric Spectrometry Group, 56 Arbury Road, Cambridge, or from the Honorary Secretary, Photobiology Group, Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3.

A CONFERENCE on the Rheology of Disperse Systems, organized by the British Society of Rheology, will be held in the Natural Sciences Building of the University College of Swansea, Singleton Park, Swansea, during September 19–21. Accommodation has been arranged at the University hall of residence. Further details can be obtained from the Hon. Secretary of the British Society of Rheology, Mr. N. Wookey, 52 Tavistock Road, Edgware, Middlesex.

A CONFERENCE on "Operational Research" has been organized by the Operational Research Society (United Kingdom), the Operations Research Society of America and the Institute of Management Sciences (New York), and will be held in Oxford during September 2–6. About 250 delegates from twenty countries are expected, and reprints of the papers to be presented have been prepared. The Conference Secretary is Miss B. Kornitzer, 6 Gray's Inn Square, London, W.C.1.

ERRATUM. In the communication entitled "The Free Energy of Hydrolysis of Adenosine Triphosphoric Acid" in *Nature* of June 29, p. 1350, the factor 10^3 was omitted from col. 8 of the table. The equilibrium constants for the hexokinase reaction should read $1{\cdot}380 \times 10^3$ and similarly down that column.

NEW RESEARCH HEADQUARTERS OF THOMAS HEDLEY AND CO., LTD.

By Dr. E. R. WILSON

THE new Research Headquarters of Thomas Hedley and Co., Ltd., at Longbenton, Newcastle upon Tyne, officially opened by the Duke of Northumberland on June 14, is the result of the post-war expansion of the Company's Research Division. Only eight years ago, in 1949, modern laboratories were completed alongside Hedley's factory in City Road, Newcastle. Since that time the Research Division has grown rapidly, and with the formation of a new Basic Research Department in 1954 it became evident that much larger laboratories would soon be required. The 45-acre site at Longbenton was chosen because it had the advantages of being out of the City and yet still accessible to public transportation and utilities, and it provided ample room for future expansion. The new Research Headquarters at present occupies eight acres of this area (Fig. 1).

The new building houses the departments concerned with product research and development of both washing products and edible products. Hedley makes a sharp distinction between basic research and applied research, and (by the Company's definition) the nature of the work carried out in the new laboratories is applied research. The basic research for the Company continues to be carried out at the City Road laboratories, where the Basic Research Department has expanded into the space vacated by the applied research groups as they moved to Longbenton.

Although the Company defines the research at Longbenton as 'applied', much of it is the type of research that is commonly termed 'basic', since the work normally begins at the test-tube stage. From here it proceeds by definite steps from small-scale, glass-ware, laboratory bench reactions, in which new compounds are synthesized and evaluated for new properties, to small batch-process pilot plant equipment, and finally to small-scale continuous-process pilot plant equipment which duplicates all conditions expected in factory production.

The building is designed in two main blocks on an east–west axis with a connecting north–south block. With the exception of the rear east–west block, which houses the pilot plant area, the building is single story. It is anticipated that the remainder of the Research Division now at City Road will eventually join the group at Longbenton, and allowance has been made in the design for future expansion.

The front block is arranged so as to have executive and administrative offices on one side of the corridor with laboratories on the other side. In these laboratories, graduate chemists and their technical assistants carry out the product research work for the Company. Their purpose is to formulate all of the Company's products so that each in its field will be entirely acceptable to the consumer for performance and appeal. That this can be an extremely complex operation is illustrated by the fact that a synthetic detergent granule, for example, normally contains as many as twenty different chemical compounds which must be present in the correct proportion for optimum performance.

In order to make certain that formulations do represent improvements which are not only detect-

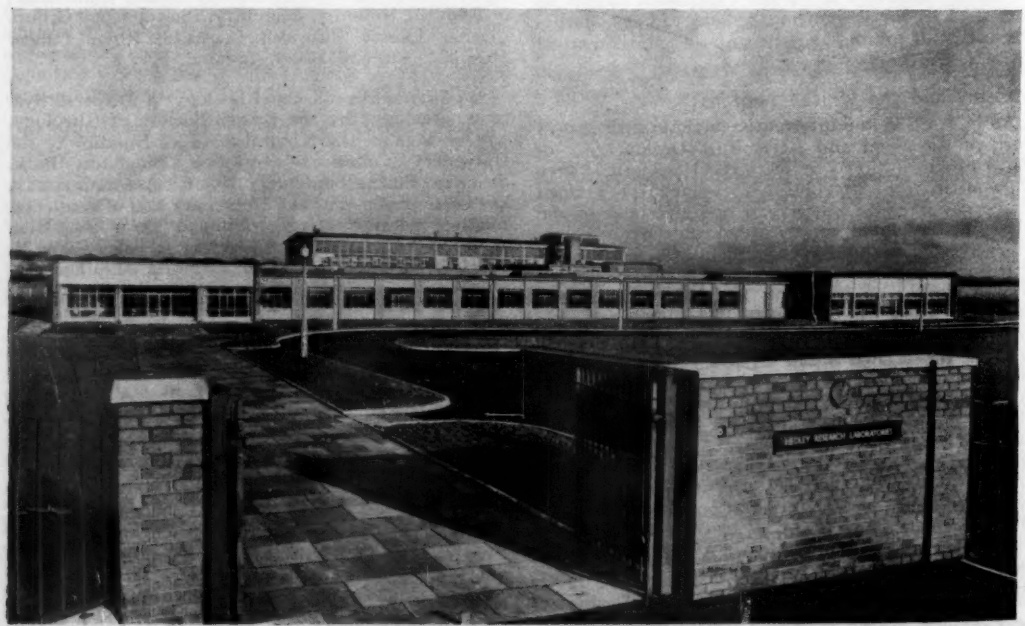


Fig. 1

able by sensitive laboratory tests but also easily seen by the final, less exact consumer, the laboratories include a research laundry and a research bakery. In the research laundry facilities have been installed which enable the scientist to set up every conceivable condition to duplicate domestic washing procedures for experimental purposes as well as to study all types of innovation, such as new washing machines, as they appear on the market. The same idea is behind the range of equipment in the research bakery, where all the problems confronting the baker can be duplicated and studied, and new shortening formulæ and recipes for the bakery trade formulated.

The back, east–west block houses the pilot plant area and the development laboratories. Approximately one-third of this two-story area is clear from floor to roof so as to accommodate the larger pilot-plant equipment. Smaller pilot-plant equipment is located under the mezzanine floor which covers the remaining two-thirds of the building. The mezzanine floor itself has offices and laboratories on both sides of a central area which is equipped with benches, fume hoods and smaller pieces of development equipment.

In these laboratories problems vary considerably in magnitude. For example, the chemist may be synthesizing previously unknown compounds to test as detergents. Simultaneously, he may be developing a new chemical process for manufacturing a detergent on a commercial scale, or developing a new formula to meet certain desired performance characteristics. He is, in effect, responsible for both the generation of ideas leading to new products and for the development of those ideas from the laboratory bench through the pilot plant to the factory.

In order to carry out such a programme, facilities include an area under the mezzanine floor for an engineering division development group as well as various service shops. This combination permits on-the-job construction of all new pilot plant and processing equipment. The north–south connecting block between the two east–west blocks contains various constant-temperature rooms, as well as additional product research laboratories. The building also contains, in the front east–west block, a technical library which is an extension of the main library in the Basic Research Department in the City Road laboratories. Also provided are a hospital suite and a large, pleasant dining room together with a modern kitchen.

Approximately 230 of the Research Division's staff of 300 are at work in the new building, which cost more than £500,000 to build and equip. At the present time, on the production side of Hedley's business, one person out of every five is engaged in some form of research.

HATFIELD TECHNICAL COLLEGE

By Dr. W. A. J. CHAPMAN
Principal

HATFIELD Technical College has just completed the first five years of its existence. The College is a unit in the plan for Hertfordshire which includes senior colleges at Letchworth, Hatfield and Watford, associated with a chain of colleges of further education. When the plan is complete, Hatfield will have close ties with colleges at St. Albans (4 miles), Welwyn Garden City (3 miles), Hertford (8 miles) and Barnet (8 miles), to offer a comprehensive service for the central portion of the county.

The College was conceived in 1947 to be on a ninety-acre site to the south of Hatfield presented to Hertfordshire County Council by Mr. A. S. Butler, at that time chairman of the de Havilland Company, Ltd. An interesting feature of the preliminary planning was the almost complete absence of any organized service of further education in the area upon which estimates of accommodation could be based. For many years previously the de Havilland Technical School at Astwick Manor had been providing the academic facilities for the Company's apprentices, and latterly the County Council participated in its work. The remainder of the population in the area sought their educational facilities in London, to which transport facilities are good.

The work on the building started late in 1948 and it was opened for classes in 1952 as the first completely new college erected after the War. The building is of modern design with the accommodation on a single floor except at the front where, due to a sloping site, the upper floor is on the level of the rest of the building. The construction is of a framed semi-prefabricated character with a reinforced concrete frame and brick in-filling. This form of construction was dictated by the shortage of steel prevalent at that time, and the bulk of the concrete frame members were manufactured at a plant set up a few miles from the site. The accommodation originally planned included facilities for engineering, science, building, commerce and social and professional studies; but about 1950, during the course of erection, the wing containing the science laboratories was subjected to an economy measure and became deferred. This necessitated some temporary improvization by the conversion of low-level accommodation and delayed the start of science work until January 1953.

When classes commenced, except for small numbers of A.F.R.Ae.S. students, the most senior work in operation was for the third year of the Ordinary National Certificate in engineering by a feed from the de Havilland Technical School which, by an arrangement with the Ministry of Education, was conducting S.2 classes. Engineering was conducted in the two departments of works and production and technical and design, with emphasis on manufacture and design, respectively. The electrical work was shared between these departments according to its practical or professional bias. From the beginning, all first-year work in engineering was conducted at the colleges of further education as the first stage of the Authority's plan to remove progressively all work up to intermediate standard. Work in all faculties other than engineering commenced at the first year of studies with a year's delay in any serious work in science.

The growth of the demand on the College and its expansion in numbers and staff have been considerable. The support was probably stimulated by the development of the new towns at Hatfield and Welwyn Garden City, and the increases in population

taking place in other parts of Hertfordshire, but no doubt the main impetus was the spirited interest shown by industry.

The County Council realized that the enlightened governance of the College would be achieved only by the inclusion of a large proportion of governors representing industry, commerce and the universities, while the representatives of the County Council themselves were men and women with wide experience of the sort of problems with which the new College was likely to be faced.

In addition to the guidance given over the years by the Governing Body itself, each department set up an advisory committee consisting of representatives of the industry concerned with particular technologies. The influence of these committees has been immeasurable. Busy executives have given up their leisure time without stint, and the confidence they have shown through this work has been an inspiration to the staff of the College.

Experience in an entirely new building, devoid of any tradition and in an area lacking anything in the way of precedent, has necessitated a few adjustments during the course of development. The initial plan of the head of a department, acting as academic registrar, proved to be impracticable and the commerce and social studies were merged into one, releasing the head of the former to take the post of academic registrar. The rapid growth of electrical engineering necessitated the formation of a separate department and some internal adaptations to provide more laboratory accommodation. The formation of a science department was delayed some twelve months from the start owing to delays in providing temporary accommodation.

A new building, especially if planned on unusual lines, excites comment, and this one was no exception. Visitors have come from all parts of the world, in some instances to make a very close study of the design and layout. Those who have been in the College during these past five years have appreciated the thought that went into its design and, now that the surroundings are mellowing, its charm and suitability for its function. In some respects, it was soon found to be too small to do all that was needed, but it has lent itself readily to minor adaptations to meet the changing demands of industry. The completion in the next two years of a new block which includes mainly laboratories, classrooms and more library accommodation will give that extra space which at present is lacking.

At the end of five years the College is now established on a firm basis with a full programme of Higher National Certificate and Diploma work in engineering, building, management and chemistry and final City and Guilds courses in various subjects. The College has a part-time degree course in aeronautical and electrical engineering and sandwich courses are being developed with a view to a future application for the Hives award. The recent visiting party from the Royal Institute of Chemistry is to recommend approval of courses for Parts I and II of the A.R.I.C. examination. The arrangements being made by the Governors and the Authority, for a number of neighbouring colleges of further education, will result in all work of intermediate standard being taken out of the College within a few years. By its character and setting, together with the tradition it has already attained, the College is well set for the responsibilities that this stage will involve.

MODERN ANALYTICAL CHEMISTRY IN INDUSTRY

WITH the increasing interest in scientific symposia and congresses one sometimes wonders wherein lies their attraction. Is it the attractiveness of the venue, the brilliance of the speakers, the interesting or topical nature of the subject-matter or is it a mere thirst for knowledge? Certainly the Congress on "Modern Analytical Chemistry in Industry", organized by the Scottish Section of the Society for Analytical Chemistry and held in the University of St. Andrews during June 24–28, had all these qualities and was an outstanding success. Three hundred delegates attended, and many more applications had to be refused. The Congress was remarkably well organized, and the organizing committee, consisting of Dr. Magnus Pyke (chairman), Mr. J. A. Eggleston (secretary), Mr. J. Brooks, Mr. H. C. Moir and Mr. A. F. Williams, had not only planned well but continued to give themselves unsparingly to ensuring the smooth running of the Congress and the comfort of the delegates.

The lectures were divided into three sections, dealing respectively with analyses in modern industry, the application of some newer analytical techniques in industry, and developments in analysis for new problems in industry. Each section was prefaced by a special lecture, the lecturers being Dr. J. Craik, chairman of the Nobel Division, Imperial Chemical Industries, Dr. E. B. Hughes, chief chemist of J. Lyons and Co., Ltd., and Prof. G. F. Smith, University of Illinois. Altogether, there were twenty-three lectures spread over eight sessions, each session being presided over by one of the following well-known personalities in chemistry: Prof. E. L. Hirst, Dr. H. W. Melville, Dr. D. Trail, Dr. R. Belcher, Prof. D. H. R. Barton, Dr. C. L. Wilson, Dr. D. W. Kent Jones and Dr. Magnus Pyke.

The Congress was opened by Dr. Magnus Pyke, who referred to the changes taking place in analytical chemistry. There was a basic change, the uncovering of the knowledge of the physical world and particularly the unfolding of the nature of atomic structure, bringing a simplicity to the understanding of the diverse elements. A second change was the increasing use of physical instruments to measure the progress of chemical reactions. While these needed to be supervised by an analyst understanding the operating principles of the instruments and the chemistry of the reactions which they interpreted or measured, their manipulation could be entrusted to a young girl. A third change came from changes in the chemical industry with its trend towards continuous operations and automatic control.

Dr. J. Craik then opened the first group of lectures with his introductory lecture on "Analytical Chemistry in Industry". He stressed the help given to analysis by new techniques and by the development of instrumentation, help in overcoming limitations of man-power and in enabling problems to be solved which could not have been undertaken by the older classical methods. For example, the analysis of glycerol had been greatly simplified and speeded up by adopting the sodium metaperiodate method. Even simple volumetric procedures such as the determination of sulphuric acid, nitric acid and nitro compounds could be improved by the use of automatic titrimeters. The use of some of the newer techniques had also stimulated research into the behaviour of existing

instruments; for example, the use of gas chromatography had greatly increased our knowledge of the behaviour of katharometers. Dr. Craik considered that any large industrial organization needed an analytical research group, for problems were continually arising having no standard solutions and for which new techniques might be needed.

Following this lecture, Dr. G. R. Davies (Chemical Research Laboratory) dealt with some of the analytical research carried out by various stations of the Department of Scientific and Industrial Research. Particular attention was directed to the work of the Building Research Station in applying differential thermal analysis to the study of building materials, to the development of automatic methods of determining dissolved oxygen by the Water Pollution Research Laboratory and to the studies of the Chemical Research Laboratory on inorganic chromatography.

Analytical methods in the iron and steel industry formed the content of the next two papers. In the first of these, Mr. B. Bagshawe (Brown–Firth Research Laboratories) directed attention to some of the many changes which had taken place in recent years. Specifications were more exacting, more elements were being determined and a much larger use was being made of organic reagents and of absorptiometric methods. Co-operative research within the industry had led to the development of British Standard methods. Mr. Bagshawe then gave some examples of the methods employed.

Spectrographic methods of steel analysis were discussed by Mr. D. Manterfield (Steel, Peech and Tozer, Ltd.). The large tonnages of steel now being produced called for rapid methods of analyses, and by spectrographic methods steel of all types, slags and some refractories could be rapidly analysed. Mr. Manterfield then dealt with photographic and direct-reading instruments, illustrating the latter by means of the quantometer.

Mr. R. C. Chirnside (General Electric Co., Ltd.), in discussing the contribution of analysis as a research service to chemical problems in the electrical industry, directed attention to the wide variety of materials in which the electrical industry had an interest. Glass, ceramics, certain metals and alloys represented major interests, but fluorescent materials, thermionic coatings, semi-conductors, etc., had been developed and were manufactured. Much of the analysis carried out by industry was meaningless, Mr. Chirnside said, and still consisted in a catalogue of acidic and basic oxides. The analyst should have a greater interest in his answers and in interpreting his results to others. The failure of the conventional presentation of results to represent a composition was demonstrated by reference to an ore containing copper and zinc sulphides which could not be separated by flotation because they were present, not as a mixture of sulphides, but as a complex as shown by X-ray diffraction. Further examples of the uses of many techniques in dealing with analytical problems were given.

Physical methods of analysis used by the gas industry were described by Mr. A. B. Densham and Mr. G. Gough (North Thames Gas Board). Mr. Gough dealt with absorption, emission and fluorescent spectroscopy and gave examples of their use. Mr. Densham then discussed the use of chromatography, radioactive tracers, polarography, X-ray diffraction and differential thermal analysis.

Dr. G. M. Bennett (Government Chemist) gave an interesting review of the activities of his department. In addition to the immense volume of revenue work, advice and service were provided for other Government departments. Dr. Bennett then dealt with some of the problems encountered in the revenue work, where the methods of assessing duty on alcohol, tobacco and sugar were all laid down by law. Topics dealt with by the non-revenue divisions were illustrated by the development of methods for determining toxic gases in factory atmospheres, the analysis of flours, nutritional surveys and the identification of the cause of the outbreak of food poisoning at Pontardawe in South Wales.

The final paper in this first section was by Dr. D. C. Garratt (Boots Pure Drug Co., Ltd.), who dealt with analytical developments in a pharmaceutical laboratory. He instanced the analysis of metals by complexiметric titrations, by emission spectroscopy and by flame photometry. Paper chromatography was used for assessing the activity of freshly prepared samples of insulin, insulin solutions and insulin zinc suspensions. Alkaloids were separated quantitatively on columns of oxidized cellulose.

The second group of lectures, on the application of some newer analytical techniques in industry, was introduced by Dr. E. B. Hughes's lecture on "Analysis and Food". Before beginning the lecture he read a tribute to the late Dr. L. H. Lampitt, who had originally been asked to deliver this lecture. Dr. Hughes began by saying that analysis was the backbone of the food industry. There were chemical safeguards for the buying, processing, cooking and packaging of food products. The care required to prevent any variation in the products was illustrated by the close control exercised during the manufacture of the large volume of ice cream and the miles of Swiss roll produced daily. Dr. Hughes then referred to the importance of controlled humidity in microecological work, to the separation of the constituents of tea extracts by paper chromatography and to the use of X-ray diffraction in routine analysis and research.

In the next lecture Dr. R. L. M. Synge (Rowett Research Institute) discussed the application of some of the physico-chemical methods, which had proved useful for the analytical separation of smaller molecules, to substances of high molecular weight. Counter-current distribution and chromatography based on liquid–liquid partition were considered as well as ion exchangers and solid adsorbents, including molecular sieve effects. A number of electrophoretic methods were described as well as procedures depending on differences in diffusion behaviour or on selective permeability in membranes.

"Emission Spectroscopy in Industrial Analysis" was the title of the paper by Mr. M. Milbourn (Metals Division, Imperial Chemical Industries). Various aspects of this technique were dealt with, including the scope of the method and the directions in which future progress is needed.

Dr. A. T. James (Medical Research Council), speaking on "Analyses in Medical Research", pointed out that there were few analysts in medical research. Each research worker carried out his own analytical work, for this varied with each problem. The general conduct of such a research was outlined and illustrated from the work on hypertensin, on the antagonist of dihydrostreptomycin and on the fatty acids derived from animal sources.

Infra-red spectroscopy was dealt with by Dr. A. E. Martin (Grubb, Parsons and Co., Ltd.), who described the modern equipment available, including the less

expensive instruments of restricted range which were very suitable for analytical use, and also instruments for process control. The various techniques available and a number of interesting analytical determinations were outlined.

An interesting account of the application of modern methods to the analytical problems of the plastics industry was given by Dr. J. Haslam (Plastics Division, Imperial Chemical Industries). Reference was made to chromatographic studies of hydrolysates from nylon and related products, to the examination of complex plasticizers in polyvinyl chloride and to the depolymerization of 'Perspex' and examination of the monomers by gas chromatography.

In his paper on "Modern Analytical Chemistry and the Rarer Metals", Mr. A. R. Powell (Johnson, Matthey and Co., Ltd.) showed how the increasing industrial use of these metals had called for rapid methods of analysis. Lithium, rubidium and cæsium were conveniently determined by flame photometer, while spectrophotometry was useful in estimating the rare earths or the platinum metals. For that very important field of analysis, the determination of trace impurities in pure metals, the examples chosen were platinum in palladium and arsenic in germanium. The determination of non-metallic impurities in pure metals was also mentioned.

"Analytical Research in the Nobel Division of I.C.I." was the title of Mr. A. F. Williams's paper, and he showed that some of the problems encountered could only have been solved by modern methods. Chromatography had been used to separate glycerol from sugars, diphenylamine from its nitro derivatives and to separate 2 : 4- and 4 : 6-dinitroresorcinols from the mononitro compound, followed in the last case by polarographic determination. Analysis of mixtures of methyl chlorosilanes by vapour phase chromatography was also described.

A thought-provoking paper by Dr. B. W. Bradford (Billingham Division, Imperial Chemical Industries) on "Process Analytical Control" brought this second session to a close. Dr. Bradford dealt with the implications of the analytical service on the working process, the cost of analytical control, the difficulties of getting junior staff for routine analysis and the consequent development of instrumentation. The final objective was the linking of continuous analytical control on the plant to the actual process. Dr. Bradford then dealt with developments at Billingham in automatic analytical instruments ; where possible, physical methods were used, while in other cases analytical procedures were mechanized. Examples were given of the use for control analysis of automatic titrimeters, optical, mass and X-ray spectrometers and gas chromatography.

The third group of lectures was opened by Prof. G. F. Smith (University of Illinois), whose topic was "New Analytical Reagents in Industrial Plant Control Operations". He pointed out that in spite of the emphasis on instrumental methods of analysis, wet chemical methods were still highly important. Recent years had seen an enormous development in organic analytical reagents, and reference was made to some of these and particularly to complexones and ion-exchange resins. Many organic reagents were of a non-specific character, but specificity could often be increased by structural modification. Progress on these lines was slow because the analyst depended on the organic chemist to do this for him instead of doing it himself. Prof. Smith then gave examples of the use of periodates, ceric salts and perchloric acid in analysis and said that these reagents deserved a wider use.

In the absence of Mr. A. Smales through illness, the next paper, on the use of radioactive and stable isotopes in industrial and analytical problems, was given by Dr. D. J. Ferrett (Harwell). He first outlined those properties of the nucleus which could be used for analytical purposes, including spin and mass, and followed with a consideration of equipment and of health hazards in dealing with tracers. The interaction of a stable nucleus with radiation could lead to attenuation, radioactivity or secondary emission, and analytical procedures depending on these were discussed. Vacuum spark and isotope dilution methods of mass spectrometry were considered, while brief reference was made to nuclear magnetic resonance.

Mr. D. A. Patient (Baird and Tatlock (London), Ltd.) then described the 'B.T.L. Analmatic' range of automatic instruments. Three categories were dealt with : (1) semi-automatic equipment needing an operator to prepare samples and work out the results ; (2) equipment to cater for techniques involving the handling of a large number of discrete samples ; and (3) fully automatic laboratories.

Polarography was covered by three experts in this field from the U.K. Atomic Energy Authority (Dr. G. C. Barker, Mr. G. W. C. Milner and Mr. H. I. Shalgosky). Mr. Milner briefly compared the various types of polarograph and then described a wide range of analytical applications of the square-wave model. Mr. Shalgosky then dealt with the cathode-ray instrument, which was rapid and easy to operate and was well suited for routine analysis. Dr. Barker finally discussed the limitations of the square-wave polarograph and the methods being adopted to increase its sensitivity.

Gas chromatography was mentioned in many lectures, but it was left to Dr. A. I. M. Keulemans (Koninlijke Shell Laboratory, Amsterdam) to deal more fully with the subject, particularly in its application to the petroleum industry. Describing chromatography as the greatest single advance in analytical methods since the discovery of emission spectroscopy, he said that its techniques had soon been used by the petroleum industry. The value of gas chromatography was illustrated by its successful application to two problems : (*a*) the determination of impurities in *cyclo*-pentadiene ; and (*b*) the explanation of the presence of acetone in doubly distilled methyl *iso*butyl ketone.

In the last paper of the Congress, Prof. C. F. Davidson (St. Andrews) dealt with the geochemical approach to prospecting. In prospecting for mineral deposits, the economic geologist had increasingly to direct his attention to sub-surface ore bodies hidden beneath tropical soils, forests, bogs and other covering. In this search he was becoming more dependent on geochemical aids. Sometimes a metal might be found by the company it kept or by mass spectrographic studies of absolute age. In other cases, analyses of soils, groundwaters, streams or vegetation might point to geochemical anomalies reflecting the presence of a nearby ore-body.

Looking back on the Congress, one could not help being impressed by the keenness and enthusiasm of those who attended. Session after session, the lecture hall was crowded with eager listeners ; discussions inside and outside the hall were on a high level and few who attended could have failed to gain much knowledge which should prove valuable in later days.

G. R. Davies

ELECTRONICS IN AUTOMATION

"ELECTRONICS IN AUTOMATION" was the title given to the British Institution of Radio Engineers' Convention held in Cambridge during June 27–30. The philological challenge invited by the word 'automation' should first be answered. It may be classed as an item of that vigorous technical slang which profitably accompanies the advance of the specialized arts. Such words may start as an adaptation or corruption of some accepted dictionary word but eventually acquire a specialized significance. The present word denotes the replacement of human operations by automatic systems in industrial and scientific processes. This tendency is not new, but the remarkable increase in its tempo, which has recently been evidenced largely as a result of the introduction of electronic devices or concepts, may be interpreted as the beginning of a second industrial revolution.

The economic and social implications of this situation were discussed by the president, G. A. Marriott, in his opening address. His conclusions may be summarized in his remark that "The only serious threat to the British economy and standard of living would be failure to take advantage of every possible aid from automation".

The papers were supplemented by an important though limited exhibition of apparatus, a valuable selection of films bearing on automation and a range of visits.

The papers were grouped into six sessions under the following headings: (1) Office machinery and information processing, (2) machine tool control, (3) chemical and other processes, (4) automatic measurement and inspection, (5) simulators, (6) automation in the electronics industry.

In the first session the papers emphasized the importance of the ferro-magnetic store, which seems likely to take over the memory function in computors to an overriding extent. Another logical operation which created great interest was concerned with the automatic reading of typed or printed characters.

Session 2 presented convincing details as to the increasing importance of automation in the control of machine tools; for example, the operation of a jig borer from punched card or other digitally stored data. A problem associated with these operations is the accurate measurement of table movements. A new and interesting solution to this, the 'Inductosyn', was the subject of a separate paper. The construction of the 'Inductosyn' is relevant to Session 6, since the device amounts to a 'resolver' with accurately printed windings.

The papers presented in Session 3 were arranged in two groups, the first dealing with the problems of instrumentation for the control of process streams in atomic energy projects and the uses of radioactive techniques in process control, while the second dealt with the process control of chemical plants from a more general point of view. Automatic sampling methods are essential in atomic energy plants and involve the engineering of laboratory methods which were described in one paper, while two papers showed how the measurement of absorption of radiation provides methods of monitoring the density of fluids in pipes from outside or for controlling the level in vessels. In the field of general process control, the possibilities of programming the controller by means of punched cards or by a computer were discussed in some detail.

Session 4 emphasized that basically an automation system must depend on the inspection of its final product and a paper in this session was devoted to the special advantages of various devices. Other papers described the control of steel strip manufacture, and automatic ultrasonic and X-ray inspection techniques. The ultrasonic system employs scanning to speed up the inspection of castings, plates, etc., while image intensification of the fluoroscopic picture is used in many industrial processes.

A more apt title for Session 5 could perhaps have been "Simulators and Analogue Computors". Under the first heading three of the four papers were devoted to training devices, namely, radar simulators for military purposes, and a training simulator for nuclear power plant operations. The degree of realism introduced in these devices was notably high. The analogue computor group embraced applications to the design of aero-engine controls, and the study of elastic beams. A general paper presented the case for analogue versus digital computing in certain cases. These two devices are complementary and in some cases digital methods may be incorporated in analogue machines. This involves an analogue/digital converter, the subject of a separate paper.

The emphasis of Session 6 was on printed circuits and associated manufacturing methods. The important subjects of automatic valve production and automatic component production were excluded by security considerations. One paper gave the most complete disclosure to date of the giant Cossor printed wiring installation. There seems no possible doubt that printed wiring plus a limited degree of printed component technique will take over almost completely from previous methods. Most printed wiring manufacture involves a liquid etching process. One manufacturer, concerned with long-life telephone apparatus, prefers to avoid a possible corrosion hazard by relying on mechanical engraving. Although the printed-wiring board by itself constitutes a major advance, it is possible also to render the assembly and soldering processes fully automatic. Advanced technique was shown, but it must be recognized that, assembly costs being small in relation to component costs, major economies can be found only by reducing the latter.

The discussion on these subjects tended to limit unduly the economic aspects, with perhaps insufficient recognition of the technical and sociological advantages which the new techniques imply.

L. H. BEDFORD

TENSORS IN ELECTRICAL ENGINEERING

A RESIDENTIAL six-day course on "Tensors in Electrical Engineering", organized by the Extra-Mural Department, was held in the University of Liverpool during the Easter vacation. The lectures were given in one of the University halls of residence, where the students were accommodated. Twenty-five graduates from industry, government establishments and universities and colleges attended.

An introductory lecture was given by Dr. W. J. Gibbs, of the British Thomson-Houston Co., Ltd., and sixteen lectures were given by J. W. Lynn and

C. V. Jones, from the University Department of Electrical Power Engineering. Ample opportunity for discussion was available at the end of each lecture, and Dr. Gibbs encouraged and guided informal discussions each evening. The enthusiastic and often heated arguments which took place may be considered as a measure of the success of the course.

Since some of the students had no previous knowledge of tensor analysis, the opening lectures were devoted to the elements of matrix algebra and its application to electrical problems. The discussions showed that those to whom the subject was new were impressed by the practical nature of the method in its applications to numerical analysis. It was shown that the equation $V = ZI$ could be applied directly to complex circuits by replacing the quantities V, I and Z by the corresponding matrices. The use of compound matrices in obtaining the inverse of Z was explained and the delta-star transformation and Thevenin's theorem were included as special cases of matrix transformation.

The introduction of tensor analysis followed the general lines developed by Gabriel Kron, who in 1934 made the first of his significant contributions to the mathematical treatment of electrical machines and networks by tensor methods. It was shown that the simple transformation of co-ordinates in geometry or field analysis, $A^a = C^a_a A^a$, could be used in electrical systems for interconnecting the windings of machines and networks. The fact that power is invariant to such an interconnexion leads to the following equations: $I^a = C^a_a I^a$; $V_\beta = C^b_\beta V^a_b$; $Z_{\gamma\delta} = Z_{cd} C^c_\gamma C^d_\delta$;

where the Greek affixes indicate quantities in the new system. Since static networks form a holonomic electrical system, they can be analysed by tensor transformations. However, when windings are rotating with respect to each other they may have non-holonomic constraints, depending on the reference axes chosen. Some useful reference axes (such as those rotating with a synchronous flux wave) can be included only by use of non-holonomic equations. The general analysis of machines involves these more advanced concepts, which were next introduced. In particular, intrinsic and covariant derivatives of vectors and tensors are required. Stress was laid upon the work of Ricci, which showed that if in a differential equation which holds for rectangular Cartesian co-ordinates, ordinary derivatives be replaced by intrinsic derivatives and partials by covariant derivatives, then the modified equations hold for general curvilinear co-ordinates. The application of this theorem to electrical machinery is as follows. If the tensor equation of a stationary machine is

$$V_a = R_{a\beta}\, i^\beta + L_{a\beta} \frac{\mathrm{d}i^\beta}{\mathrm{d}t}$$

then when the machine is rotating the corresponding equation is

$$V_a = R_{a\beta}\, i^\beta + L_{a\beta} \frac{\delta i^\beta}{\delta t}$$

where $\frac{\delta i^\beta}{\delta t}$ is the intrinsic derivative and

$$\frac{\delta i^\beta}{\delta t} = \frac{\mathrm{d}i^\beta}{\mathrm{d}t} + \Gamma^\beta_{\gamma a}\, i^\gamma\, i^a$$

The general machine equation then becomes

$$V_a = R_{a\beta}\, i^\beta + L_{a\beta} \frac{\mathrm{d}i^\beta}{\mathrm{d}t} + \Gamma_{\beta\gamma,a}\, i^\beta\, i^\gamma$$

The different forms of $\Gamma_{\beta\gamma,a}$ which arise under different operating conditions and with different reference axes were next introduced. The terms arising because of non-holonomic constraints were studied in detail.

The long-established rules and concepts of the tensor calculus were seen to lead to a generalized theory of electrical machinery. The power and flexibility of these tensor applications, due to Kron, are becoming more widely recognized.

ROYAL BOTANIC GARDENS, KEW

REPORT FOR 1956

THE review of the work of the Royal Botanic Gardens, Kew, during 1956 follows the general pattern of earlier reports (*Kew Bull.*, No. 1; 1957). During the year Sir Edward Salisbury, who had been the director for thirteen years, retired and was succeeded by Dr. George Taylor, keeper of botany in the British Museum (Natural History).

The Herbarium staff, as usual, has dealt with a truly vast amount of material and has been visited by some 4,455 botanists, many of these from the Commonwealth and other countries overseas. The report also records extensive and varied inquiries on botanical matters and the receipt of many consignments of plants. The work on several floras has been sustained and constitutes a notable effort in scholarship.

In the Department of Economic Botany the number of inquiring visitors has been greater than in the previous year. Inquiries cover a great deal of ground, often of an interesting and important character. It would be impossible in a short note to do more than touch on one or two points. The distribution of economic plants still ranks as an important function of this section. The propagation of cacao was actively continued during the greater part of the year, and many plants were dispatched from the Quarantine House. These consisted chiefly of materials collected in Colombia during 1952 and forwarded to Kew in 1954 via the Imperial College of Tropical Agriculture in Trinidad. After the required period of supervision in quarantine, the plants were propagated as rooted cuttings, which were sent on to the West Africa Cacao Research Institute as materials for its breeding programme. It is noted that a variety of cacao from a widely different source, known as Lafi No. 7 from Samoa, has now been propagated and distributed. This material has aroused wide interest because of its reputation for high yielding capacity and its possible disease-resistance properties. Rooted cuttings have now been sent to Trinidad, West Africa and Malaya for trials under differing conditions. The work of the Quarantine House in relation to banana problems follows the lines reported on in previous years. Special interest is attached to some varieties of the diploid *Musa acuminata*, collected in New Guinea and Malaya, which in due course will be used in the breeding programme in the Caribbean.

An important result of the work of the Jodrell Laboratory is that a draft of practically the whole of

a work on the anatomy of the grasses has been prepared and should, it is hoped, be ready for the press before the end of 1957; and anatomical studies of other monocotyledons have been published or are in progress. The routine work of the Laboratory is concerned with the very diverse, and sometimes diverting, materials submitted for examination: in 1956 a piece of wood from Herod's palace at Jerusalem was found to be *Juniperus oxycedrus*.

The report also deals comprehensively with the work in progress in the Gardens, including its several sections from the Arboretum to the Tropical House. It concludes with a record of the papers published during the year together with a staff list.

C. W. WARDLAW

THE CIVIL SERVICE

REPORT FOR 1956–57

THE ninety-first report of H.M. Civil Service Commissioners, covering the period April 1, 1956–March 31, 1957*, again notes a decrease in the number of candidates for the open competitions of the administrative class. Although the number of entries was the lowest since 1949 and only thirty-three out of the fifty vacancies allotted to this competition were filled, the entry for the 1957 competitions appears to be somewhat stronger both in number and in quality than that of 1956. To fill vacancies left by the 1955 open competition, a supplementary competition for the administrative class was held in the summer of 1956 to offer an opportunity to those who had remained at the universities for research, or had taken up other employment and had outstanding intellectual ability. Of the twenty-one candidates, the five who were successful had been engaged in research or in university teaching since graduating. The limited competition for the administrative class was somewhat more successful than in the previous year, and the results of the innovations tried seem encouraging. Recruitment to the statistician class remained difficult and the number competing for the special departmental class declined further. The open competitions for the executive class produced enough recruits to fill the vacancies notified, but it was only the adoption of a new competition based on the General Certificate of Education that maintained the level of recruitment among young people. The growing proportion of women candidates in some competitions, particularly those for the executive and clerical classes, suggests that the achievement of equal pay by 1961 is increasing the attractiveness for a woman of a career in the Civil Service. The method of continuous open competition was used for all scientific classes, and the results of the senior scientific officer/scientific officer competitions were relatively satisfactory, especially in the senior grade, for which recruitment appears to be easier than that of scientific officers of the quality and in the numbers required by departments. The greatest deficiency was in filling posts for scientific assistants, though a fair number of the vacancies are being filled by temporary people who are gaining the two years experience required to qualify them for the competitions.

The quality of candidates attracted by the research fellowship competition remains high, and the departments concerned appear to have been impressed very favourably by the work of those in the past. Of the twenty-seven fellowships offered this year, nine senior and thirteen junior fellowships have been awarded. Although the competition for patent examiners took a slight turn for the better, the number of vacancies is so large, and the problem of recruitment so difficult, that for a limited period candidates are being considered who hold honours degrees in non-scientific subjects. It remains as difficult as ever to recruit candidates with technical qualifications for the factory inspectorate. The information work of the Commission increased both in volume and in complexity and an information officer was appointed to organize and develop it. The arrangement made in 1955 whereby younger members of the administrative class act as links between the Civil Service and their own colleges or universities appears to fulfil a real need, and the arrangement made in December 1956 for sixty undergraduates, representing most of the British universities, to spend a week visiting Government departments also appeared to be a success.

* Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1956, to 31st March, 1957. Pp. 40. (London: H.M. Stationery Office, 1957.) 2s. 3d. net.

ACCIDENTS IN CHILDHOOD

A YEAR ago the European Regional Office of the World Health Organization asked a group of experts from many countries to consider how accidents in childhood could be prevented. In most countries in Europe infant and child mortality has been steadily decreasing in recent years, and in many places has reached significantly low figures. Deaths due to infections and nutritional disturbances have fallen to a level considered unattainable only a few years ago. Against this, the death-rate due to accidents remains high and for many types of accidents has increased. As disease becomes more effectively controlled, accidents are assuming a proportionately greater importance. In some countries they have become the chief cause of death in childhood and adolescence and account for 30–40 per cent of all deaths in the age-group 1–19 years. Among certain groups of children, greater numbers are killed by accidents than by all other causes combined. This unenviable prominence of accidents in child mortality throughout Europe is due to the new and dangerous hazards introduced into many homes and countries by modern technological progress. The spread of electrification, especially in rural areas, the introduction of highly potent insecticides, the increasing numbers of motor-cars and bicycles on roads designed for thirteenth- to fifteenth-century traffic, may be cited as examples.

It is not only as a cause of death that accidents in childhood are important. The number of non-fatal accidents is very much larger—100–200 times greater and by some estimates even more.

In a preliminary survey the advisory group examined the main causes of accidents and at what ages they occurred*. These showed that mortality from accidents is highest at the pre-school age, lowest among school children, and again somewhat higher in adolescence. Since the beginning of this century,

* World Health Organization. Technical Report Series, No. 118: Accidents in Childhood: Facts as a Basis for Prevention. Report of an Advisory Group. Pp. 40. (Geneva: World Health Organization; London: H.M. Stationery Office, 1957.) 1 Swiss franc; 1s. 9d.; 0·30 dollars.

mortality from accidents has decreased for the pre-school group, remaining at almost the same level in the school-age and adolescent groups. The decrease in pre-school age accident mortality took place in spite of a growing traffic accident toll, as a result of diminishing deaths from drowning and burns and scalds. In school age and adolescence, the increasing traffic accident mortality cancelled out the decrease in deaths from other accidental causes.

The main groups of fatal accidents in children are those caused by motor-vehicles, drowning, and fire and burns, the proportion varying from one country to another. Accident mortality was found to depend upon the peculiarities of the situation in which the population was living. In some countries, for example, although the number of motor-vehicles in use is rising, the accident-rate is not increasing in like proportion.

Analysis by sex as well as age reveals important differences. The aggregate accident mortality in the European region shows that the rates for boys are double or triple those for girls at most ages. The least difference is observed at the younger ages. There is a marked preponderance among boys and male adolescents of injuries associated with outdoor activities, and among girls of burning accidents caused through the wearing of light inflammable clothing.

Not unexpectedly, the group found that mortality data do not in themselves give a complete indication of frequency or of social and economic consequences of accidents. Morbidity data is required to complement mortality statistics and to expose potentially dangerous accidents. While mortality from accidental poisoning is low in most countries, morbidity studies have revealed a high frequency of accidental poisoning. Morbidity studies also show that a certain attitude of carelessness and instability of purpose are much more prevalent among those children who have had accidents. Children of this type often come from broken homes or problem families; their recklessness and disregard of consequences is primarily a mental factor which may at times express itself in physical behaviour resulting in unforeseen accidents.

The advisory group was unable to make detailed examination of the possible methods of preventing accidents to children but, in principle, showed that the bases of accident prevention fall into three categories: education; engineering; regulation and law enforcement. At present much of the organized accident prevention work for children in Europe is directed to traffic and road safety; such activities should be increased in view of the growing importance of motor-vehicles as a cause of injury to children. A substantial number of programmes should also be directed to safety in the home and its vicinity and to the prevention of drowning accidents. Many of the organizations which at present limit their efforts to traffic-safety campaigns could with advantage turn their attention to other hazards of childhood and undertake preventive measures in co-operation with those who are primarily concerned with child welfare. In one country, for example, the pædiatricians, working through their national and local committees, have been largely instrumental in developing, in co-operation with the pharmaceutical industry, measures to minimize the hazard from aspirin poisoning and, in co-operation with paint manufacturers, a standard for a paint which is safe for use on children's toys, furniture and interior surfaces. Pædiatricians in some countries, because of their special interest in the infant and pre-school child, have led the movement to focus attention on accident prevention in this age-group—the least accessible to organized safety education and yet the one with the highest accident mortality-rates of childhood. Physicians who supervise the health of infants and children, public health nurses, nursery school teachers, and others with access to the family and homes of these small children, have begun to give guidance in accident prevention as a part of their instruction in child care. For some years past, schools in many countries have been giving training in road safety. Some countries provide instruction in swimming and first-aid and on the safe use of the bicycle. The use of the home safety check-list, taken home by the school-child, is a part of the safety programme of some school systems.

RELATIONSHIP BETWEEN THE HYDROLYSIS OF ADENOSINE TRIPHOSPHATE AND OXIDATIVE PHOSPHORYLATION

By W. C. HÜLSMANN and Prof. E. C. SLATER
Laboratory of Physiological Chemistry, University of Amsterdam

In a recent preliminary communication[1] from this Laboratory it was reported that liver and heart mitochondria contain four different enzyme systems which bring about the hydrolysis of added adenosine triphosphate. Three of these systems, designated by their *p*H-optima 6·3, 7·4 and 8·5, were stimulated by dinitrophenol. It was suggested that these three different adenosine triphosphatases might be related to the three dinitrophenol-sensitive phosphorylative steps in the respiratory chain. An earlier formulation[2] of the oxidative phosphorylation was expanded into

$$AH_2 + B + I \rightleftharpoons A \sim I + BH_2 \quad (1)$$

$$A \sim I + X \rightleftharpoons X \sim I + A \quad (2)$$

$$X \sim I + ADP + H_3PO_4 \rightleftharpoons X + I + ATP \quad (3)$$

$$X \sim I + H_2O \xrightarrow{(DNP)} X + I \quad (4)$$

Reaction (1) represents the hydrogen (or electron) transfer reaction in which energy is conserved by combination of the oxidized product with I; reaction (2) is an energy-transfer reaction; while reaction (3) is the phosphorylation reaction. It is supposed that

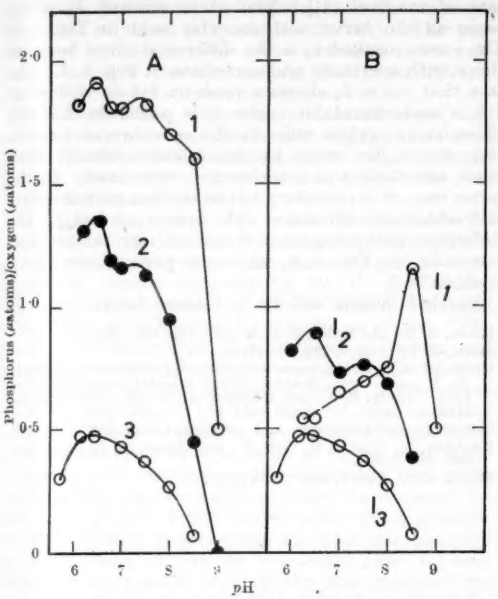


Fig. 1*A*. The effect of *p*H on the phosphorus/oxygen ratio measured with guinea pig heart mitochondria (sarcosomes) and ascorbate (curve 3), succinate (curve 2) and DL-glutamate (curve 1) as substrate. In every case, the reaction mixture contained tris-acetate buffer, 0·05 *M*; magnesium, 0·005 *M*; glucose, 0·01 *M*; adenosine triphosphate, 2×10^{-4} *M*; phosphate, $2{\cdot}25 \times 10^{-2}$ *M*; ethylenediamine tetraacetate, 6×10^{-4} *M*; potassium chloride, 0·03 *M*; sucrose (except with ascorbate), 0·05 *M*; hexokinase; sarcosomes 0·26–0·4 mgm. protein/ml. Cytochrome *c* ($1{\cdot}65 \times 10^{-5}$ *M*) was used only with ascorbate. Concentrations of substrates were: ascorbate, 0·03 *M*; succinate, 0·05 *M*; DL-glutamate, 0·01 *M*. Curves 1 and 2 represent the means of two experiments, in which both substrates were studied with the same mitochondrial preparations. Curve 3 is the mean of two experiments with two other mitochondrial preparations, treated under hypotonic conditions as described in ref. 6

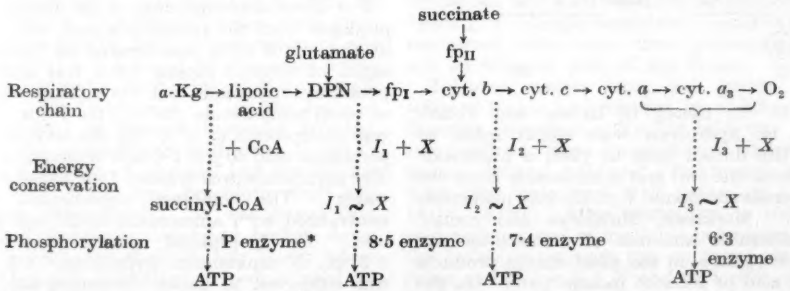
Fig. 1*B*. The *p*H-activity curves of each phosphorylative enzyme, calculated as described in the text

reaction (4) is absent in intact liver mitochondria but becomes very fast in the presence of dinitrophenol. Added adenosine triphosphate is then hydrolysed by the reverse of reaction (3), followed by reaction (4). The three dinitrophenol-sensitive enzymes have *p*H optima characteristic of three different reactions (3), involving three different *I*'s (I_1, I_2 and I_3). The same *X* could be concerned in all reactions.

Since reaction (3) in the forward direction is responsible for oxidative phosphorylation, this explanation implies that, in certain circumstances, the latter will show the same *p*H-optima. This would not be expected when reaction (4) is lacking, as in intact mitochrondria, since each molecule of AH_2 oxidized must then be accompanied by the synthesis of one molecule of adenosine triphosphate, and the phosphorus/oxygen ratio would be independent of the *p*H. When, however, reaction (4) is operative, the phosphorus/oxygen ratio of each phosphorylative step equals {rate of reaction (3)}/{rate of reaction (3) + rate of reaction (4)}, and might be expected to show the *p*H-dependence of reaction (3). This has been found to be the case with heart mitochondria (sarcosomes) which, in our hands, give phosphorus/oxygen ratios appreciably below those found with liver mitochondria. In the experiments shown in Fig. 1, hexokinase was added to trap the adenosine triphosphate, and so prevent reaction (3) proceeding from right to left.

The *p*H activity curves of the phosphorus/oxygen ratio (Fig. 1,*A*) show three peaks with glutamate (at *p*H's about 6·4, 7·4 and 8·5), two with succinate (at about 6·4 and 7·4) and one with ascorbate (6·3). The number of peaks corresponds to the number of phosphorylative steps associated with these three substrates, and the *p*H-optima for oxidative phosphorylation are the same as those found for the dephosphorylation of adenosine triphosphate in the presence of dinitrophenol. This is very strong support for the suggestion of Hunter and Lardy[3] that the two phenomena are related (see also ref. 4), and for the type of mechanism represented by equations (1)–(4) above. Our findings completely disprove an alternative hypothesis for the mechanism of action of dinitrophenol, namely, that the uncoupling of oxidative phosphorylation is a consequence of the increased hydrolysis of adenosine triphosphate. If this were true, phosphorylation would have minima not optima at *p*H's where the hydrolysis is optimum.

Our results also enable us to locate the *p*H-optima of the three different phosphorylation reactions in the respiratory chain. The 6·3 enzyme, which is common to all three substrates, must be associated with the cytochrome oxidase end of the chain. The 8·5 enzyme is found with glutamate, but not with succinate or ascorbate, and must, therefore, be associated with the phosphorylation in the region of



* See ref. 5.

(The following abbreviations are used: α-Kg, α-ketoglutarate; DPN, diphosphopyridine nucleotide; fp_I, flavoprotein (diaphorase); fp_{II}, flavoprotein (succinic dehydrogenase); cyt., cytochrome; CoA, coenzyme A; ATP, adenosine triphosphate.)

diphosphopyridine nucleotide which is not concerned in the oxidation of succinate or ascorbate. The 7·4 enzyme, which is found with both glutamate and succinate, but not with ascorbate, must lie somewhere in the middle of the respiratory chain.

Although the oxidation-reduction steps in the respiratory chain which are linked with phosphorylation are not yet definitely identified, there is increasing evidence that they are located as in the accompanying scheme. (The role of cytochrome-*b* in the main chain is still doubtful.) The horizontal arrows represent the hydrogen (or electron) transfer reactions (1). The two sets of vertical dotted arrows represent the energy conservation and transfer in reactions (1) and (2), and the phosphorylation reactions (3). The nature of I_1, I_2, I_3 and X remains completely unknown. In the substrate-linked phosphorylation with α-ketoglutarate, which is not affected by dinitrophenol, coenzyme A takes the place of both I and X.

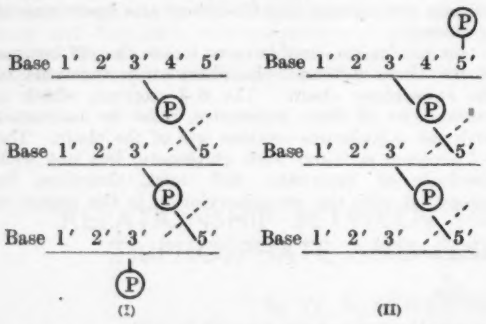
The *p*H-activity curves of each phosphorylation reaction are illustrated in Fig. 1,*B*. (Strictly speaking, the curves in Fig. 1,*B* represent the effect of *p*H on the ratio {rate of reaction (3)}/{rate of reaction (3) + rate of reaction (4)}. The curve marked I_3 is the same as the curve with ascorbic acid in Fig. 1,*A*. The curve marked I_2 is the difference curve between those with succinate and ascorbate in Fig. 1,*A*. The fact that curve I_2 shows a peak at 6·4 as well as at 7·5 is understandable, since it is probable that the phosphorus oxygen ratio in the cytochrome oxidase step was higher when succinate was substrate than when ascorbate and cytochrome *c* were used. In the latter case, it is necessary to use swollen mitochondria and added cytochrome *c*. The curve marked I_1, the difference curve between those with glutamate and succinate in Fig. 1,*A*, shows a particularly sharp peak at 8·5.

Further details will be published later.

[1] Myers, D. K., and Slater, E. C., *Nature*, **179**, 363 (1957).
[2] Slater, E. C., *Nature*, **172**, 975 (1953).
[3] Hunter, F. E., in "Phosphorus Metabolism", **1**, 297, edit. by McElroy, W. M., and Glass, Bentley (Johns Hopkins Press, Baltimore, 1951). Lardy, H. A., and Wellman, H., *J. Biol. Chem.*, **201**, 357 (1953).
[4] Cooper, C., and Lehninger, A. L., *J. Biol. Chem.*, **224**, 561 (1957).
[5] Kaufman, S., Gilvarg, C., Cori, O., and Ochoa, S., *J. Biol. Chem.*, **203**, 869 (1953).
[6] Slater, E. C., *Nature*, **174**, 1143 (1954).

TERMINAL GROUPS OF TOBACCO MOSAIC VIRUS NUCLEIC ACID

IN ribonucleic acids the nucleotides appear to be held together by phosphodiester links between the 3′ and 5′ carbons of adjacent sugar residues[1]. The polynucleotide chains thus formed may be terminated with a single phosphoryl residue in either of two ways as shown diagrammatically in (I) and (II).



According to the theory of Brown and Todd[2], compound II on hydrolysis with alkali splits as indicated by the dotted lines to yield a nucleoside diphosphate from one end and a nucleoside from the other end, whereas compound I yields only nucleoside 3′-phosphates. Markham, Matthews and Smith[3] reported considerable amounts of nucleosides and nucleoside diphosphates in the alkali-fission products of ribonucleic acid of tobacco mosaic virus. On the basis of this observation, they concluded that in tobacco mosaic virus ribonucleic acid there is a large proportion of chains of type II, and since it was calculated that about one residue in fifty yields a nucleoside diphosphate, the size of the nucleic acid was estimated to be much smaller than that reported by Cohen and Stanley[4]. These observations are of importance, not only because they suggest that there are two types of ribonucleic acid in viruses, but also because of considerable interest in the essential size of the ribonucleic acid from tobacco mosaic virus in relation to its recently reported infectivity[5,6]. Therefore, an attempt was made to confirm the results of Markham *et al.*[3] employing both intact tobacco mosaic virus and isolated nucleic acid preparations.

The tobacco mosaic virus used in these studies was grown in Turkish tobacco plants and was purified by the differential centrifugation method. Ribonucleic acid from it was prepared by two different procedures: (1) a heat denaturation method[7] and (2) the phenol procedure[8]. Both the ribonucleic acid preparations had about 1 per cent of the infectivity of an equal weight of virus.

For direct determination of the alkaline hydrolysis products from the ribonucleic acid, without isolating it, the intact virus was treated as follows. To 400 mgm. of tobacco mosaic virus was added 2 ml. *N* potassium hydroxide and the mixture was incubated at room temperature (23° C.) for 18 hr. The protein was precipitated at 0° C. by the addition of ice-cold perchloric acid to *p*H 1·0 and centrifuged in the cold. The precipitate was washed four times with distilled water. The combined supernatant fluids were neutralized with ammonium hydroxide and lyophilized. The lyophilized material was taken up in 0·5 ml. *N* ammonium hydroxide. 0·3 ml. of this was subjected to paper chromatography using *iso*-propanol/water/ammonia as a solvent system[8] and 0·2 ml. to paper electrophoresis using *M*/20 phosphate buffer[3] at *p*H 7·4.

The two nucleic acid preparations were treated as follows. To 20 mgm. of nucleic acid was added

1 ml. *N* potassium hydroxide and the mixture incubated at room temperature (23° C.). The products of hydrolysis were processed and were subjected to paper chromatography and paper electrophoresis in the manner described above.

Only nucleotides were observed in all cases, and neither nucleosides nor nucleoside diphosphates were found in the alkali-fission products of the intact tobacco mosaic virus or of the two ribonucleic acid preparations made from it.

In addition, a test was made to evaluate the sensitivity of the method for detecting diphosphates as follows. Twenty-four micrograms of uridine-3′,5′-phosphate (kindly supplied by Dr. C. A. Dekker) were added to 10 mgm. of nucleic acid and treated with 1 ml. *N* potassium hydroxide as above. The products of hydrolysis were treated as before and subjected to paper electrophoresis. It was found that 85 per cent of the added uridine-3′,5′-phosphate could be recovered. On the basis of this, one may conclude that it is possible to determine nucleoside-5′-phosphate ends with an error of 15 per cent, even if there is only one such end in about 500 nucleotide residues, that is, one-tenth as many as reported by Markham *et al.*[3]. Furthermore, since it is possible readily to detect qualitatively one-half this quantity of diphosphate, it can be concluded that tobacco mosaic virus nucleic acid of the size reported by Cohen and Stanley[4] (molecular weight about 300,000), and represented by our heat denatured ribonucleic acid, seems not to end in 5′-phosphate groups.

These findings are in contrast to those of Markham *et al.*[3] and greatly reduce the probability that the ribonucleic acid of tobacco mosaic virus can be represented by chains of type II. On the other hand, the easy demonstration of 3′-phosphate ends in experiments employing phosphomonoesterase treatment (Markham *et al.*[3], and our unpublished observations) leads to the conclusion that the nucleic acid of tobacco mosaic virus is probably of type I.

If tobacco mosaic virus ribonucleic acid is type I, it would be valuable to determine the number of 3′-phosphate terminal groups. However, the phosphomonoesterase treatment for 18 hr. at 37° C. at *p*H 5·3 as used by Markham *et al.*[3] was found unreliable in a quantitative sense with our ribonucleic acid, because the conditions alone, without any esterase, caused a partial degradation of the ribonucleic acid to yield dialysable fragments and, of course, new end-groups. This was demonstrated as follows. 5·49 mgm. of tobacco mosaic virus ribonucleic acid prepared by heat denaturation of the virus[7] was dissolved in 0·8 ml. of *M*/10 acetate buffer of *p*H 5·3 and dialysed against 1 ml. of *M*/10 acetate buffer of *p*H 5·3 for 18 hr. at 37° C. (a few drops of toluene were added to prevent bacterial growth). The dialysate was concentrated to dryness at 50° C. by blowing in a current of nitrogen and the residue was digested with 70 per cent perchloric acid[9] and phosphorus was determined[10]. It was found that 1·14 per cent of the nucleic acid had broken down and passed through the dialysis bag under these conditions. Thus the incubation procedure used by Markham *et al.*[3] creates more end-groups than were originally present, and it appears that a precise determination of 3′-phosphate ends will require first the establishment of conditions for stabilizing the nucleic acid.

In summary, we have not been able to confirm the results leading to the conclusion that tobacco mosaic virus ribonucleic acid represents a type of nucleic acid characterized by 5′-phosphate ends or that it is substantially smaller than the early estimates[4]. On the other hand, our results are consistent with those expected from nucleic acid characterized by 3′-phosphate ends.

This investigation was supported by grants from the Rockefeller Foundation and the Lederle Laboratories Division, American Cyanamid Company, and a research grant, *E*-634, from the National Institutes of Health, United States Public Health Service.

K. K. Reddi
C. A. Knight

Virus Laboratory,
University of California,
Berkeley, California. June 7.

[1] Cohn, W. E., and Volkin, E., *Nature*, **167**, 483 (1951). Markham, R., and Smith, J. D., *Biochem. J.*, **52**, 558 (1952). Brown, D. M., and Todd, A. R., *J. Chem. Soc.*, 2040 (1953). Whitfield, P. R., and Markham, R., *Nature*, **171**, 1151 (1953). Heppel, L. A. Markham, R., and Hilmoe, R. J., *Nature*, **171**, 1151 (1953).
[2] Brown, D. H., and Todd, A. R., *J. Chem. Soc.*, 52 (1952).
[3] Markham, R., Matthews, R. E. F., and Smith, J. D., *Nature*, **173**, 537 (1954).
[4] Cohen, S. S., and Stanley, W. M., *J. Biol. Chem.*, **144**, 589 (1942).
[5] Fraenkel-Conrat, H., *J. Amer. Chem. Soc.*, **78**, 882 (1956).
[6] Gierer, A., and Schramm, G., *Nature*, **177**, 702 (1956).
[7] Knight, C. A., in "Methods in Enzymology", **3**, 684 (1956).
[8] Markham, R., and Smith, J. D., *Biochem. J.*, **52**, 558 (1952).
[9] Reddi, K. K., *Biochim. et Biophys. Acta*, **24**, 238 (1957).
[10] King, E. J., *Biochem. J.*, **26**, 292 (1932).

Markham, Matthews and Smith[1] have given evidence for the existence of ribonucleic acid chains terminated by nucleoside residues bearing singly esterified 5′-phosphate groups. They found that alkaline hydrolysis of certain ribonucleic acids, including that from tobacco mosaic virus, yielded small amounts of nucleoside-5′,3′ (or 2′) diphosphates and nucleosides in addition to the nucleoside 3′- and 2′-monophosphates. The nucleoside diphosphates originate from terminal nucleoside residues bearing 5′-phosphomonoester groups, while the nucleosides come from residues at the other end of the chain bearing no singly esterified phosphates. The relative proportions of these products in alkaline hydrolysates of tobacco mosaic virus ribonucleic acid led to the conclusion that this nucleic acid had a mean chain-length of 50 nucleotide residues.

Further investigation of tobacco mosaic virus nucleic acid has shown that the latter conclusion is erroneous, and that while short polynucleotide chains bearing 5′-phosphomonoester end-groups may be associated with some virus preparations, they are not an intrinsic part of the virus.

Tobacco mosaic virus was grown on Turkish tobacco plants and purified by a differential centrifugation procedure. Nucleic acid was prepared by two methods: heat denaturation[2], or treatment with sodium dodecyl sulphate[3]. The nucleic acid preparations were hydrolysed in *N* potassium hydroxide for 18 hr. at 20°. After neutralization with perchloric acid and removal of insoluble potassium perchlorate, the hydrolysates were run on paper electrophoresis, either at *p*H 5 in 0·1 *M* acetate buffer, or at *p*H 9 in 0·05 *M* borate buffer. Both methods serve to separate the nucleosides and nucleoside diphosphates from the nucleoside-2′- and 3′-monophosphates. The quantities of hydrolysate used were such that nucleoside diphosphates in amounts of 0·1 per cent of the

mononucleotides could easily have been detected. No nucleoside diphosphates were found in hydrolysates of either of the two types of nucleic acid preparations.

We attempted to establish the nature of the material giving rise to nucleoside diphosphates previously observed in tobacco mosaic virus preparations isolated by ammonium sulphate precipitation. Eight strains of tobacco mosaic virus described by Siegel and Wildman[4] were chosen, because these strains differ in the amounts of coloured material present in the purified virus preparations. They were grown in White Burley tobacco plants, and the virus isolated by heat clarification of the plant sap followed by ammonium sulphate precipitation. The virus nucleic acids were prepared by heat denaturation[2]. Alkaline hydrolysates of nucleic acid preparations from all the strains contained nucleoside diphosphates and nucleosides, but the proportion of nucleoside diphosphates/mononucleotides (0·1–1 per cent) varied not only among the strains but also with different preparations of the same strain. There was no correlation between the amounts of nucleosides and nucleoside diphosphates in the hydrolysates, nor were these related to the presence of coloured material in preparations of some of the virus strains. On dialysis at 37° against 0·1 *M* citrate buffer *p*H 7 (a procedure similar to that used by Ginoza, Atkinson and Wildman[5] to remove non-viral nucleoprotein) and subsequent isolation of the virus by centrifugation, almost all the material giving rise to nucleoside diphosphates on alkaline hydrolysis could be removed from the virus. The properties of this material suggest that, if it is a polynucleotide, it is of low molecular weight. However, it cannot be separated from the virus by centrifugation before incubation with the citrate buffer and appears to be associated with the virus particles or other high-molecular weight material present in virus preparations obtained in this way.

These observations show that there is no evidence that tobacco mosaic virus nucleic acid consists of chains terminated by 5′-phosphomonoester end-groups.

R. E. F. Matthews

Plant Diseases Division,
Department of Scientific and Industrial Research,
Auckland, New Zealand.

J. D. Smith

Agricultural Research Council
Virus Research Unit,
Molteno Institute, Cambridge.

June 11.

[1] Markham, R., Matthews, R. E. F., and Smith, J. D., *Nature*, **173**, 537 (1954).
[2] Knight, C. A., in "Methods in Enzymology", edit. by Colowick, S. P., and Kaplan, N. O., **3**, 684 (Academic Press, New York, 1956).
[3] Fraenkel-Conrat, H., and Williams, R. C., *Proc. U.S. Nat. Acad. Sci.*, **41**, 690 (1955).
[4] Siegel, A., and Wildman, S. G., *Phytopath.*, **44**, 277 (1954).
[5] Ginoza, W., Atkinson, D. E., and Wildman, S. G., *Science*, **119**, 269 (1954).

GENETICS OF THE β-LACTOGLOBULINS OF COW'S MILK

By R. ASCHAFFENBURG and J. DREWRY

Chemistry Department, National Institute for Research in Dairying, University of Reading

THE occurrence of different β-lactoglobulins in cow's milk has been briefly reported[1]: by means of paper electrophoresis at *p*H 8·6, the milk of individual animals was shown to contain either two components ($\beta_{1,2}$), or only the faster-moving (β_1) or slower-moving (β_2) of these. The preliminary results suggested that the formation of these proteins is controlled by a single gene, and we now present more extensive evidence in support of this hypothesis.

The terms β_1- and β_2-lactoglobulins were first used by Polis, Shmukler, Custer and McMeekin[2] for describing subfractions of crystalline β-lactoglobulin prepared from bulk milk. As these subfractions are different from the components present in the milk of individual cows[3], changes in nomenclature are now proposed. These have been chosen so as to bring the notation into line with genetical usage. The proteins should be called β-lactoglobulin A (instead of β_1), B (instead of β_2) and *AB* (instead of $\beta_{1,2}$). Animals can then be described as of phenotype β-lactoglobulin A/A, B/B or A/B, and of genotype Lg^A/Lg^B, etc., using *Lg* as the locus symbol for the single gene believed to be involved.

The samples to be subjected to paper electrophoresis for typing purposes were prepared by a modification of our procedure[4] for the isolation of the crystallizable proteins of milk. As in this procedure, a filtrate containing the 'lactalbumins' is first obtained by adding sodium sulphate to whole milk (20 gm./100 ml.). The 'lactalbumins' are then precipitated with ammonium sulphate (20 gm./100 ml.), collected on a filter paper, dissolved in a little distilled water, and finally dialysed for at least 90 min. against running tap-water. By starting the fractionation in the morning, samples can be conveniently prepared for electrophoresis overnight.

This typing procedure has been applied to the milk of nearly 300 cows. Most of the animals, including 24 pairs of one-egg twins, have come from the Institute herds. The results obtained with 278 cows, subdivided according to breed, are given in Table 1. On the assumption that the genotypes correspond with the observed phenotypes, the gene frequencies have been obtained by counting. Under conditions of random mating, and in the absence of strong selective effects, application of the Hardy–Weinberg formula should then result in close agreement between the observed numbers and those expected from the theory of genetic equilibrium. As shown in Table 1, such agreement is, in fact, obtained, and this applies not only to the total population, but also to all but one of the rather small sub-groups. It holds, in particular, for the Shorthorn population, and it is, perhaps, of interest that all the animals included in this group are descendants of stock established at the Institute for well over thirty years. In view of these

Table 1. OBSERVED AND EXPECTED* FREQUENCIES OF β-LACTOGLOBULIN TYPES (278 COWS†)

Breed		No. Total	A/A	A/B	B/B	χ^2 (1 d.f.)	P	Gene frequency A	B
Shorthorn‡	obs.	87	1	17	69	< 0·01	> 0·95	0·11	0·89
	exp.		1·03	16·90	69·07				
Friesian	obs.	87	13	44	30	0·23	0·50 < < 0·70	0·40	0·60
	exp.		14·06	41·84	31·08				
Guernsey	obs.	27	1	10	16	0·038	> 0·90	0·22	0·78
	exp.		1·33	9·33	16·34				
Ayrshire	obs.	54	2	29	23	3·77	0·05	0·31	0·69
	exp.		5·04	22·91	26·05				
Miscellaneous§	obs.	23	4	12	7	0·086	0·50 < < 0·70	0·44	0·56
	exp.		4·35	11·31	7·34				
All breeds	obs.	278	21	112	145	< 0·01	> 0·90	0·28	0·72
	exp.		21·33	111·35	145·32				

* From Hardy–Weinberg law.
† Monozygous twins counted as one.
‡ All animals bred from N.I.R.D. stock. A few recent additions to herd listed under Miscellaneous.
§ Cross-breeds, etc.

findings, the secretion of the different β-lactoglobulins may be regarded as an example of a metabolic polymorphism of the type in which, according to Allison[5], "allelomorphic genes give rise to distinct products, both of which are present in the heterozygote".

This interpretation is supported by the available family data. Thus, no homozygote A/A was found when the daughters of 34 dams of phenotype B/B were tested; 20 of the offspring were B/B and 14 A/B. (There were only two dams of phenotype A/A; both had daughters of type A/B.) A difficulty in the interpretation of the genetics of this situation is the inability to assess the phenotype of males. However, it has been possible to infer the genotype of some of the more widely used Shorthorn and Friesian bulls from their breeding record. One such record is shown in Table 2, which permits, for example, from matings Nos. 1 and 2, or 6 and 8, the deduction that the bull in question is of genotype Lg^A/Lg^B. From such data, the segregation patterns in Table 3 have been obtained. The number of cases in the different groups is small, but the table does show that the proportions of offspring belonging to different phenotypes agree well with expectation. Thus, the family data support the conclusion drawn from the results of the gene-frequency analysis.

Table 2. FAMILY DATA FOR FRIESIAN BULL H.B.

Mating No.	Phenotype of Dam	Offspring	Mating No.	Phenotype of Dam	Offspring
1	B/B	B/B	6	A/B	A/A
2	B/B	A/B	7	B/B	A/B
3	B/B	B/B	8	A/B	B/B
4	A/B	A/B	9	A/B	B/B
5	A/B	A/B	10	—	B/B

Deduced genotype of bull: Lg^A/Lg^B

Table 3. SEGREGATION PATTERN FOR 46 OFFSPRING OF 4 DIFFERENT MATING COMBINATIONS

Mating combination*		Phenotype of offspring A/A	A/B	B/B
		No.	No.	No.
$Lg^A/Lg^A \times Lg^B/Lg^B$	obs.	0	4	0
	exp.	0	4	0
$Lg^B/Lg^B \times Lg^B/Lg^B$	obs.	0	0	8
	exp.	0	0	8
$Lg^B/Lg^B \times Lg^A/Lg^B$	obs.	0	10	10
	exp.	0	10	10
$Lg^A\ Lg^B \times Lg^A/Lg^B$	obs.	2	6	6
	exp.	3·5	7	3·5

* Since bulls cannot be classified with certainty as Lg^A/Lg^A or Lg^B/Lg^B, combinations involving such bulls must be regarded as probable mating types.

That the secretion of the different β-lactoglobulins is under strict genic control is further emphasized by the findings with one-egg twins, of which twenty-four sets have now been tested. Without exception, the twins in each set produced the same form of β-lactoglobulin. In contrast, four out of five pairs of two-egg twins were found to secrete different β-lactoglobulins. As a diagnostic aid in the testing of twin cattle, β-lactoglobulin typing is clearly of limited value: it can only be applied to the lactating female, and the results can only be used to disprove that twins are monozygous. One-egg twins collected by our Institute are subjected to blood-grouping tests at the Institute of Animal Breeding, Royal Agricultural College of Sweden, Upsala, using the technique described by Rendel[6]. Inspection of the blood-grouping records of the twins of known β-lactoglobulin type has not disclosed any simple and obvious relationship between the blood-groups and the β-lactoglobulin types, but the number of comparisons is small, and the existence of linkage cannot be ruled out.

In this connexion, recent work on hæmoglobin types in cattle deserves brief discussion. As first shown by Cabannes and Serain[7], cattle blood may contain two electrophoretically distinct hæmoglobins either singly or in combination, but it appears from a survey of British breeds[8] that this applies to only one of the four such breeds tested for β-lactoglobulin, the Guernsey, whereas in the remaining three (Ayrshire, Friesian and Shorthorn) only a single hæmoglobin has been found. As all four breeds are polymorphic with respect to β-lactoglobulins, the gene controlling the formation of the milk proteins is probably unrelated to that governing hæmoglobin synthesis. Like cattle, goats[9] and sheep[9,10] are also known to produce two types of hæmoglobin, while a whole series of hæmoglobin types has been discovered in human blood. The question whether similar genetically controlled differences are to be found in the milk proteins of species other than cattle is under investigation.

Since β-lactoglobulins A and B are distinctly different proteins[1,3], they are likely to differ in some of their effects. In searching for the possible physiological significance of such differences, it must be borne in mind that, under natural conditions, milk is produced in order to nourish the young, so that differential effects may have to be sought in the calf that receives the milk rather than in the cow that secretes it. Too little is, as yet, known about the

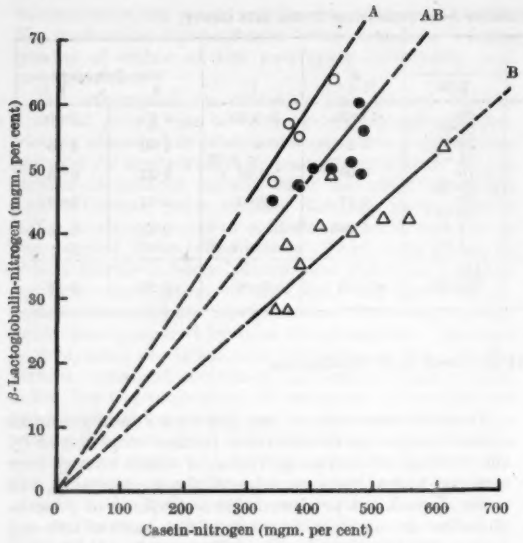


Fig. 1. Concentration of the β-lactoglobulins and of casein in the milk of 24 individual cows

detailed composition of the β-lactoglobulins to consider possible qualitative differences, such as might arise from variations in the amino-acid composition of the proteins. That there are considerable quantitative differences in their output is shown by the following results. These have been obtained by determining the concentration of the β-lactoglobulins, using a newly developed analytical procedure (Aschaffenburg, R., and Drewry, J., unpublished work), and of casein, using Rowland's method[11], in the milk of single cows of different breed, age and state of lactation (excluding the colostral stage).

By plotting β-lactoglobulin against casein concentration for each specimen, as shown in Fig. 1, some marked regularities are brought out. The concentration of each of the β-lactoglobulins varies in proportion to the casein content, the relation being different for each type. This suggests some form of quantitative relationship between β-lactoglobulin and casein synthesis, possibly during the early stages of their build-up from a common amino-acid pool. By fitting linear equations to the data, as shown in the figure, the following slope constants were obtained: $k_A = 0{\cdot}150$; $k_{AB} = 0{\cdot}122$; $k_B = 0{\cdot}087$. These findings indicate that, given equal yields of milk of comparable casein content, an animal homozygous for the Lg^A-allele will produce almost twice as much β-lactoglobulin as the other homozygote, while the output of the heterozygote falls about half-way between that of the two homozygotes. If the β-lactoglobulins are synthesized for a specific nutritional purpose, it might be concluded that the enhanced capacity for β-lactoglobulin production conferred by the Lg^A-allele would be advantageous to the calf. Yet in all the cattle breeds tested the frequency of Lg^B is higher than that of Lg^A. The simplest explanation, from the point of view of population genetics, for the stability of such a polymorphism is that the relative fitnesses of the three genotypes are as follows: Lg^A/Lg^B, Lg^B/Lg^B, Lg^A/Lg^A. Thus it seems that the β-lactoglobulins may have some other physiological effects which influence the selective values of the several genotypes.

We wish to thank Dr. A. C. Allison (Oxford) for generous help and guidance.

[1] Aschaffenburg, R., and Drewry, J., *Nature*, **176**, 218 (1955).
[2] Polis, B. D., Shmukler, H. W., Custer, J. H., and McMeekin, T. L., *J. Amer. Chem. Soc.*, **72**, 4965 (1950).
[3] Ogston, A. G., and Tombs, M. P., *Biochem. J.*, **66**, 399 (1957).
[4] Aschaffenburg, R., and Drewry, J., *Biochem. J.*, **65**, 273 (1957).
[5] Allison, A. C., *Heredity*, **10**, 1440 (1956).
[6] Rendel, J., Seventh Int. Congr. Anim. Husb. (Madr.), Subj. **2**, 113 (1956).
[7] Cabannes, R., and Serain, C., *C.R. Soc. Biol., Paris*, **149**, 7 (1955).
[8] Bangham, A. D., *Nature*, **179**, 467 (1957).
[9] Harris, H., and Warren, F. L., *Biochem. J.*, **60**, xxix (1955).
[10] Evans, J. V., King, J. W. B., Cohen, B. L., Harris, H., and Warren, F. L., *Nature*, **178**, 849 (1956).
[11] Rowland, S. J., *J. Dairy Res.*, **9**, 42 (1938).

HISTOCHEMICAL APPEARANCES OF CHOLINESTERASE IN THE NORMAL SCIATIC NERVE AND THE CHANGES WHICH OCCUR AFTER NERVE SECTION

By Dr. R. S. SNELL
Department of Anatomy, King's College, London

It has been reported on many occasions that cholinesterase is highly concentrated in nerve fibres. Sawyer[1] showed by chemical analysis that the sciatic nerve in the guinea pig contains a large amount of cholinesterase, and approximately 57 per cent of this is true cholinesterase while the remainder is pseudo-cholinesterase. Koelle[2] found by histochemical examination that in the cat, rabbit and rhesus monkey high concentrations of true cholinesterase were located in the cholinergic neurones and lower concentrations in the adrenergic and sensory neurones. Giacobini[3] also investigated the problem on nervous tissue from the frog, rat and cat, using a modification of the Koelle method. He found that neurones, which had been isolated by microdissection from spinal, sympathetic and parasympathetic ganglions and from the anterior and lateral horns of the spinal cord, contained large concentrations of true cholinesterase in the cytoplasm and nerve processes. The results showed that in these different types of cells there was a high concentration of true cholinesterase in the cytoplasm at the axon hillock and at the surface of the axon. The majority of the nerve fibres isolated from the anterior roots of spinal nerves of the rat also showed a high concentration of true cholinesterase. Attempts to evaluate the degree of true cholinesterase activity in the different parts of the axon (root, node, internode) using isolated fibres

from the frog's sciatic nerves did not give any valid results. Nachmansohn[4] is of the opinion that the presence of cholinesterase in nerve fibres is intimately related to the propagation of nerve impulses along the axons.

The present investigation was designed to demonstrate histochemically the distribution of cholinesterase in a mixed peripheral nerve and to study the effect of nerve section on the concentration and distribution of this enzyme in the individual nerve fibres.

Forty-six mature guinea pigs were used for this investigation. Twelve of the animals were used for studying the distribution of cholinesterase in the normal sciatic nerve. In seventeen of the animals the right sciatic nerve was cut in mid-thigh and a portion about 1 cm. long was removed. In the remaining seventeen animals the right sciatic nerve was also cut, but the two ends were immediately approximated by means of a single fine silk suture. Animals from the last two groups were killed at intervals over a period of six weeks following the operation. The sciatic nerves were removed from each guinea pig and in the case of those which had had the right sciatic nerve cut the left normal nerve was also removed to serve as a control. The nerves were fixed in 10 per cent formol saline for 15 hr. Longitudinal frozen sections 30μ thick were then cut. Transverse sections were also cut of the normal nerves at 50μ thick after they had been impregnated with a dilute solution of gum arabic for one hour. The sections were washed in distilled water for half an hour and then processed using a modification of the histochemical technique described by Koelle and Friedenwald[5]. The sections were incubated with the substrate solutions for 48, 72 and 96 hr. at *p*H 4·2. The cholinesterase appearances in the sciatic nerves were assessed by studying the concentration and distribution of the copper sulphide precipitate formed. In order to distinguish between the cholinesterase group of enzymes and the other esterases a number of the nerve sections were treated with incubating solutions also containing 3×10^{-5} *M* concentrations of eserine. The results were as follows.

Appearances of cholinesterase in the normal sciatic nerve. Cholinesterase was found to be concentrated mainly in the axons and in the neurilemmal sheaths. In the axons the cholinesterase appeared to be evenly distributed along their lengths and throughout their breadths. In the neurilemmal sheaths the enzyme was seen to be evenly distributed throughout the Schwann cells, and in the transverse nerve sections appeared as a black ring around each axon (Fig. 1). No obvious difference in the concentration of cholinesterase could be detected in the nerve fibres of differing diameters. A small amount of cholinesterase was found in the connective tissue between the nerve fibres. In those sections which had been incubated with substrate solutions containing eserine no enzyme activity could be detected.

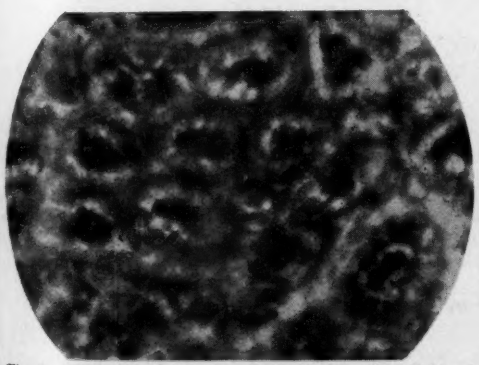


Fig. 1. Photomicrograph of transverse section (50μ thick) of normal sciatic nerve of guinea pig. Shows cholinesterase to be concentrated mainly in the axons and in the neurilemmal sheaths. The cholinesterase appears black in the photomicrograph. Stained histochemically for cholinesterase. No counterstain used. × 1,870

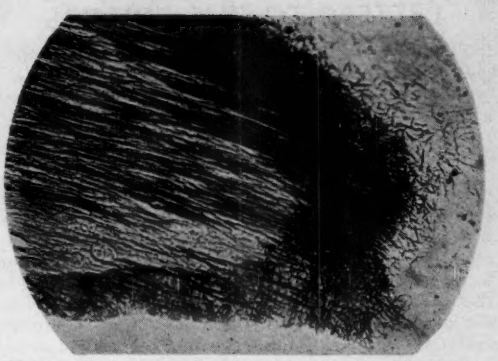


Fig. 2. Photomicrograph of longitudinal section of proximal portion of sciatic nerve of guinea pig 20 days after nerve section and suture. Shows large number of neurofibrils growing out of the proximal stump containing a very high concentration of cholinesterase. The cholinesterase appears black in the photomicrograph. Stained histochemically for cholinesterase. No counterstain used. × 145

Appearances of cholinesterase in the sciatic nerve following nerve section. In the nerves which had been cut and not sutured the concentration of cholinesterase in the proximal portion remained normal, while in the distal portion the cholinesterase became reduced in amount as degeneration proceeded. When regeneration commenced the nerve fibrils growing out of the proximal stump were found to contain a very high concentration of cholinesterase (Fig. 2), much greater than that seen in the normal nerve; and similar appearances were noted in the nerve fibrils growing into the peripheral neurilemmal tubes in the nerves which had been cut and sutured. In those sections which had been incubated in substrate solutions containing eserine no enzyme activity was seen.

The high concentration of cholinesterase seen in the nerve fibrils growing out of the proximal stump would account for the high concentration of this enzyme found by chemical analysis in the neuroma of the proximal stump by Couteaux and Nachmansohn[6] and by Sawyer[1]. Furthermore, the fall in concentration of cholinesterase in the peripheral stump during Wallerian degeneration is almost certainly due to the disintegration of the axis cylinders, since only a small amount of residual cholinesterase was seen in the peripheral neurilemmal tubes. In these investigations no distinction was made between true and pseudo-cholinesterase.

I gratefully acknowledge the technical assistance of Miss J. M. Burke with this work.

[1] Sawyer, C. H., *Amer. J. Physiol.*, **146**, 246 (1946).
[2] Koelle, G. B., *J. Pharmacol. and Exp. Therap.*, **114**, 167 (1955).
[3] Giacobini, E., *Acta Physiol. Scand.*, **36**, 276 (1956).
[4] Nachmansohn, D., *Bull. Johns Hopkins Hosp.*, **83**, 463 (1948).
[5] Koelle, G. B., and Friedenwald, J. S., *Proc. Soc. Exp. Biol. Med.*, **70**, 617 (1949).
[6] Couteaux, R., and Nachmansohn, D., *Nature*, **142**, 481 (1938).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Hole and Claw Defects in Graphite

In the ideal crystal, graphite consists of infinite sheets of fused aromatic rings, packed in parallel and with hexagonal symmetry of the atoms. Actual crystals of graphite show various types of departure from this ideal structure. These include defects in the packing of the parallel layers, which have been demonstrated in a variety of crystallographic studies, and defects in the macro-aromatic network which constitutes any one layer. It has long been realized that any one such aromatic macromolecule must stop somewhere. At outside edges, the carbon atoms of macro-aromatic molecules probably form organic derivatives such as C=O, C—OH, —C—H, in order to satisfy valency requirements. Some of these outside edge atoms may also form weak C—C bonds of the hexaphenyl–ethane type between pairs. Interesting new types of crystal defect are also possible at carbon atoms situated at internal points of any macro-aromatic network, whenever such atoms are not joined to two carbon neighbours as in the planes of ideal graphite.

If such defect sites are completely closed in by macro-aromatic network, 'aromatic holes' are formed. Two examples are illustrated in Fig. 1, but there are many others. If they are situated at re-entrant portions of the network which are not closed, 'claw defects' are formed. One type is illustrated in Fig. 2; many variants can be constructed. The object of this communication is to direct attention to some properties of the carbon atoms at edges of internal holes or claws which throw some light on observations in actual crystals of graphite.

Suppose one of the carbon atoms C_a marked *a* in Fig. 1 at an internal edge defect forms a chemical bond, such as —C—H or C—OH; it may even form C=O with appropriate readjustments of other C—C bonds in the neighbourhood. Such bond formation immediately affects the possibilities of satisfying the valency requirements of carbon atoms at neighbouring sites in the hexagonal network, marked *b* in the diagram.

One possibility is that C_b atoms also form chemical bonds, just as they would at external free edges of the macro-molecule. As a consequence, the network must bulge around the 'hole' or 'claw', owing to the repulsions between the groups bonded to C_a and C_b. 'Claw' buckling of molecules which would normally be planar has been established by optical activity and X-ray methods[1] in smaller aromatic molecules.

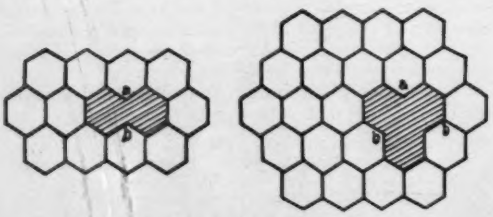


Fig. 1. Naphthalene 'hole'

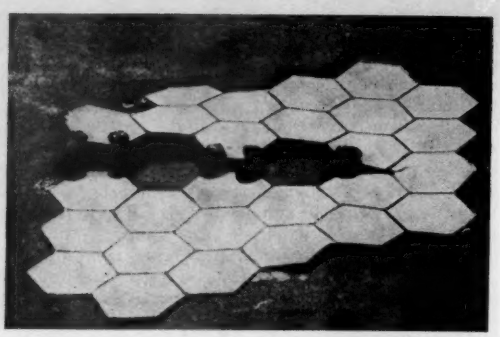


Fig. 2

There is some evidence[2] that this out-of-plane buckling and distortion must extend over several carbon atoms around the 'hole' or the internal tip of the 'claw'. In any carbon macro-molecule that would constitute a layer in ideal graphite, out-of-plane buckling starts at a claw defect and can lead to far-ranging out-of-plane co-operative defects. In building a claw macro-molecule, the structure with lowest energy is that which balances repulsion energy between foreign atoms joined to C_a, C_b, against the loss of resonance energy resulting from the out-of-plane configurations of the fused carbon rings. Various types of claw formation can be envisaged to satisfy this condition. These need not be detailed here, but it is useful to note that the consequences of a single claw defect in a macro-aromatic network has a bearing on catalytic influences in the chemical reactivity of solid carbon.

Alternative to the formation of chemical bonds at C_a, C_b, with consequent buckling of the macro-aromatic network, a second possibility is that the planar configuration is conserved, despite the defect. This could happen, for example, at an 'aromatic hole' in one macro-aromatic layer, firmly sandwiched between perfect macro-aromatic layers above and below it, at approximately the normal *c* spacing of 3·54 A. At such defect sites, C_a can still form a chemical bond with a foreign atom such as —C—H, leaving C_b vacant as a 'trapped unpaired spin'. Because of the compensating effect of repulsion energy in the crystal and the energy of spin pairing, the arrangement

$$\begin{cases} C_a \text{ combined with a foreign atom} \\ C_b \text{ spin unpaired, one electron deficit} \end{cases}$$

can have a lower potential energy than

$$\begin{cases} C_a \text{ combined with a foreign atom} \\ C_b \text{ combined with a foreign atom} \end{cases}$$

as discussed in the first possibility. In this case, the hole (or, though less likely, the claw) can provide a mechanism for the trapping of unpaired spins. This could have a bearing on the interesting observation[3] on unpaired electron spins which are observed in partly ordered graphite, as disordered carbon is progressively heated.

A. R. Ubbelohde
Imperial College of Science and Technology,
London, S.W.7.
July 12.

[1] Cf. Cook, Annual Reports Chem. Soc., **39**, 173 (1942). Bell and Waring, *J. Chem. Soc.*, 2, 689 (1949). Newman, Lutz and Ledmeier, *J. Amer. Chem. Soc.*, **77**, 3420 (1955).
[2] McIntosh, Robertson and Vand, *J. Chem. Soc.*, 1661 (1954).
[3] Ingram, *Nature*, **174**, 797 (1954).

Sources of Radio Noise on the Planet Jupiter

THE discovery in 1955 by Burke and Franklin[1] of a source of radio noise corresponding to the position of the planet Jupiter was confirmed by Shain[2], who reviewed a series of old records taken in an investigation of cosmic noise at 18·3 Mc./s. during 1950–51. Shain found that certain noise bursts, which previously had been assumed to be interference, corresponded to the times when Jupiter was passing through the reception beam of the aerial system. He then expressed the times at which these noise bursts occurred in terms of the System I and System II zenocentric longitudes used for Jupiter (corresponding respectively to rotation periods of 9h. 50m. 30s. in the equatorial belt and 9h. 55m. 40·6s. for the rest of the planet) and found that a certain periodicity was shown in the System II longitudes, corresponding to a localized source at a longitude of 67°. The results were correlated, so far as possible, with visual observations made by the Jupiter Section of the British Astronomical Association, and the possible identification of the noise source with a visual disturbance in the Southern Temperate Belt was discussed.

A further investigation of the Jupiter radio noise has been made in this laboratory at 18·0 Mc./s., using an eight-dipole aerial array having a beam width, to the half-power points, of about 30° in the east–west direction. A series of daily records were taken from December 31, 1956, to March 8, 1957; nearly every record was taken in the presence of an observer to guard against recording unwanted interference. It was found that the noise bursts occurred less frequently than when observed by Shain during 1950–51; a total of sixty-seven observations yielded thirty-seven useful records on which the radiation appeared with a good degree of certainty.

Following Shain, the times when the noise bursts occurred were expressed in longitudes of the central meridian during the bursts, and these are shown for System II in Fig. 1. Histograms were made of the frequency of occurrence of the noise for 5-deg. intervals of central meridian longitude, and these are shown in Fig. 2. In System I the distribution appears to be random, but in System II the noise bursts occur most frequently in two longitude bands centred on about 105° and 210°, each band having a maximum

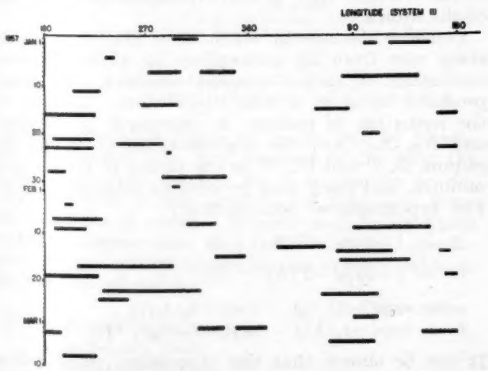


Fig. 1. Observed periods of noise in terms of System II zenocentric longitude

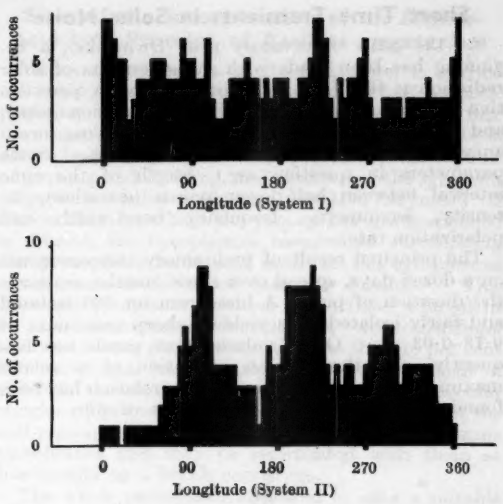


Fig. 2. Histograms showing frequency of occurrence of the noise bursts for 5-deg. intervals of central meridian longitude in both System I and System II

width of about 90°. This suggests the existence of two sources of noise, with the possibility of a somewhat weaker source centred on about 290°, near the present longitude of the Red Spot.

A final correlation of the radio observations with possible visual features is awaiting reports from the British Astronomical Association and the Association of Lunar and Planetary Observers on the current apparition of Jupiter. It would seem likely from both Shain's and our observations that any radio noise which has been observed so far is due to a localized source, or sources, and is not distributed over the whole body of the planet.

The narrow longitude band-widths of the two sources indicated in Fig. 2 suggest the existence of an ionosphere on Jupiter, since the longitude band-widths should be at least 180° if no refraction effects occur. If a localized source is assumed and the critical angle is taken as 45° (half the longitude band-width), then an electron density of the order of 10^6/cm.^{3} is indicated, which is comparable to that of the Earth.

Shain's source was found to have a longitude band-width of about 135°; this could have been due to two overlapping sources, possibly the same two sources observed by us, drifts in longitude having taken place to separate the sources and to change the longitudes of their centres.

It is hoped to publish a more detailed account of this work elsewhere. One of us (C. H. B.) is studying in the United States under the Fulbright Programme sponsored by the Institute of International Education.

C. H. BARROW
T. D. CARR
A. G. SMITH

Department of Physics,
University of Florida,
Gainesville, Florida.
June 1.

[1] Burke, B. F., and Franklin, K. L., *J. Geophys. Res.*, **60**, 213 (1955).
[2] Shain, C. A., *Nature*, **176**, 836 (1955); *Austral. J. Phys.*, **9**, 61 (1956).

Short Time Transients in Solar Noise

At the radio observatory near Dwingeloo, a beginning has been made with measurements of solar radiation at 400 Mc./s. The aim is to obtain quantitative data about transients of short duration (pips), and possibly some insight into the underlying mechanism which excites the coronal plasma. Some parameters in question are: length of the time interval between half-power points (duration), intensity, asymmetry, frequency band-width and polarization-rate.

The principal result of preliminary measurements on a dozen days, spread over three months, concerns the duration of pips. A histogram on 500 isolated and fairly isolated ones yields a sharp maximum at 0·18–0·03 sec. Other values occur much less frequently, and there is no indication of a second maximum of less than 1 sec. No correlation has been found between duration and height of pips.

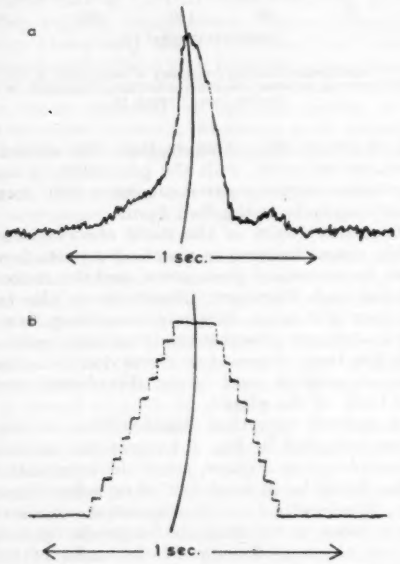


Fig. 1. (*a*) Record of a typical pip. (*b*) Record of a step voltage illustrating resolving power in time of recorder

Perhaps the time interval between successive pips is a relevant quantity during noise storms. Such a period on August 29, 1956, yielded 0·25 ± 0·04 sec.; the mean duration was 0·13 ± 0·03 sec.

The fact that these values come out with a rather low spread suggests that they are related to an elementary phenomenon, amenable to theoretical description. Reber[1] has put forward a hypothesis, which claims the existence of a linear relationship between wave-length in metres and duration of pips in seconds, the constant of proportionality being one. Apparently this does not hold when the wave-length is 0·75 m.

An accuracy of 0·01 sec. being readily obtainable, it seems to be worth while to determine mean durations on several wave-lengths and their dependence on time.

Thanks are due to the Radio Astronomy Section of the Netherlands PTT (Postal Service) for lending the receiver. The work has been supported financially by the Netherlands Organization for Pure Scientific Research (ZWO).

T. de Groot

University Observatory,
Utrecht.

[1] Reber, G., *Nature*, **175**, 132 (1955).

Determination of Radon and Thoron in Air

The presence of natural radioactive gases in the atmosphere was first demonstrated more than fifty years ago, and in recent years interest has been renewed in the subject.

A method for determination of radon favoured by the later investigators has been filtration of about 1 cubic metre of air, and subsequent detection of the activity found on the filter using a particle counter or ionization chamber; radon passes through the filter and the short-lived activity observed is that of the four immediate daughter products attached to dust particles. With appropriately large volumes of air, a similar procedure is suitable for the determination of thoron products, the activity of which still remains when, after the lapse of a few hours, radon products are virtually decayed. Activity remaining after a few days is attributable to fission dust.

Published figures of natural radioactivity show some differences which are difficult to reconcile, and, in so far as investigators have been reticent in indicating their methods of calculation, it is uncertain whether satisfactory formulation has always been achieved of the equations which express the complex pattern of decay. The purpose of this communication is to put forward general expressions by which the concentration of radioactive gas may be related to the observed activity of mixed decay products in the filtration type of experiment. These expressions are a corollary of Rutherford's mathematical theory of successive changes and they are found to reduce to a simple symmetrical form.

The decay constant (λ) for each radioactive species is commonly employed in such calculations, but in the present instance there is a notational advantage in using the reciprocal of λ. This constant, denoted here as Λ, can be defined as the time in which a large number of atoms of an isolated species decays to the fraction $1/e$; Λ also represents the mean life of the atoms.

Consider the case in which air is filtered at a constant rate from an atmosphere in which the concentration of radon remains constant, the decay products being in secular equilibrium. Let Λ_A be the mean life of radium A expressed in minutes, and Λ_B, Λ_C, $\Lambda_{C'}$, the corresponding constants for radium B, C and C′. T is the period of filtration in minutes, and t any time in minutes subsequent to T. For typographical convenience:

$$A = 1-\exp(-T/\Lambda_A); \quad B = 1-\exp(-T/\Lambda_B);$$

$$C = 1-\exp(-T/\Lambda_C); \text{ etc.}$$

$$a = \exp(-t_1/\Lambda_A) - \exp(-t_2/\Lambda_A);$$
$$b = \exp(-t_1/\Lambda_B) - \exp(-t_2/\Lambda_B); \text{ etc.}$$

It can be shown that the expressions which follow are a measure of the number of particles of each type emitted from the filtered material in an interval $t_2 - t_1$:

Radium A (α) : $\Lambda_A{}^2 Aa$

Radium B (β) : $\dfrac{\Lambda_A{}^2 Aa}{\Lambda_A - \Lambda_B} + \dfrac{\Lambda_B{}^2 Bb}{\Lambda_B - \Lambda_A}$

Radium C (β) : $\dfrac{\Lambda_A{}^4 Aa}{(\Lambda_A - \Lambda_B)(\Lambda_A - \Lambda_C)} +$

$\dfrac{\Lambda_B{}^4 Bb}{(\Lambda_B - \Lambda_A)(\Lambda_B - \Lambda_C)} + \dfrac{\Lambda_C{}^4 Cc}{(\Lambda_C - \Lambda_A)(\Lambda_C - \Lambda_B)}$

Radium C′ (α) : $\dfrac{\Lambda_A{}^5 Aa}{(\Lambda_A - \Lambda_B)(\Lambda_A - \Lambda_C)(\Lambda_A - \Lambda_{C'})} +$

three symmetrical terms

Substituting specific values for Λ, the expressions reduce to :

Radium A (α) : $19{\cdot}4\ Aa$

Radium B (β) : $-2{\cdot}5\ Aa + 1{,}687\ Bb$

Radium C (β) : $0{\cdot}5\ Aa + 6{,}367\ Bb - 2{,}652\ Cc$

Radium C′ (α) is virtually the same as radium C since $\Lambda_{C'}$ is very small.

After evaluating for particular time periods, each line is multiplied by a factor representing the efficiency of detection of the respective particle, and also by a factor $2{\cdot}22\ vx$, where air has been filtered at v litres per minute and x is the unknown concentration of radon in micro-micro curie per litre. The solution of x is then obtained by equating to the observed 'count'.

If an initial state of equilibrium does not exist within acceptable limits, air to be sampled should be isolated, and filtered after waiting for a period sufficiently long for transient equilibrium to be established. The expressions appropriate to this case also reduce to symmetrical form. Let Λ_O be the mean life of radon, and P the waiting period. The following examples illustrate the manner in which the expressions are modified, that is, by a common factor in each line, and a conditional factor in each denominator.

Radium A (α) : $\Lambda_O \exp\left(-\dfrac{P}{\Lambda_O}\right) \cdot \dfrac{\Lambda_A{}^2 Aa}{\Lambda_O - \Lambda_A}$

Radium C (β) :

$\Lambda_O \exp\left(-\dfrac{P}{\Lambda_O}\right) \left[\dfrac{\Lambda_A{}^4 Aa}{(\Lambda_O - \Lambda_A)(\Lambda_A - \Lambda_B)(\Lambda_A - \Lambda_C)} + \right.$

$\dfrac{\Lambda_B{}^4 Bb}{(\Lambda_O - \Lambda_B)(\Lambda_B - \Lambda_A)(\Lambda_B - \Lambda_C)} +$

$\left.\dfrac{\Lambda_C{}^4 Cc}{(\Lambda_O - \Lambda_C)(\Lambda_C - \Lambda_A)(\Lambda^C - \Lambda_B)}\right]$

Expressions appropriate to thoron can be formulated on similar lines, and because of the long life of the component thorium B, it is possible to determine thoron in the presence of relatively large concentrations of radon. Actinon and its daughter products have mean lives which make specific detection in the atmosphere almost impracticable in the presence of radon.

G. B. Courtier

Public Health Department,
The County Hall,
Westminster Bridge,
London, S.E.1.

June 20.

Sites of the Incorporation of an Amino-acid into Proteins of *Bacillus megaterium*

When the digestion of *B. megaterium* is carried out with lysozyme in suitable media of high osmotic pressure, the rod-shaped cells are converted into from one to four spherical protoplasts[1]. It has been shown by McQuillen that these protoplasts are capable of growing and dividing, and of effecting the synthesis of protein, nucleic acids, and adaptive enzymes[2]. If the medium in which the protoplasts are suspended is diluted, the cytoplasmic membranes surrounding the protoplasts burst and much of the cytoplasmic constituents is liberated into the medium[1]. This liberated cytoplasm contains no particles equivalent to the mammalian microsomes, ultracentrifugal analysis having shown that not more than 10 per cent of the material has a maximum molecular weight of 200,000, the residue being of much lower molecular weight. The bulk of the deoxyribonucleic acid of the cell remains associated with the 'ghost' cytoplasmic membranes and may be sedimented with them at low speeds on a bench centrifuge.

The whole protoplasts appeared to offer a suitable system for the study of protein synthesis in short time-intervals as it is possible to stop the process by pouring on to ice, thereby simultaneously cooling and bursting the cells with the consequent disruption of the cellular structure. Protoplasts were prepared from whole cells by aerobic incubation at 30° with lysozyme (0·2 mgm./ml.) in a glucose/ammonia/salts medium containing 0·5 *M* sodium citrate and 1 per cent casein digest. When the conversion was complete, the protoplasts were harvested and resuspended in an inorganic salts medium containing 1 per cent glucose and 0·5 *M* potassium dihydrogen phosphate, After aerobic incubation for a further 1 hr.

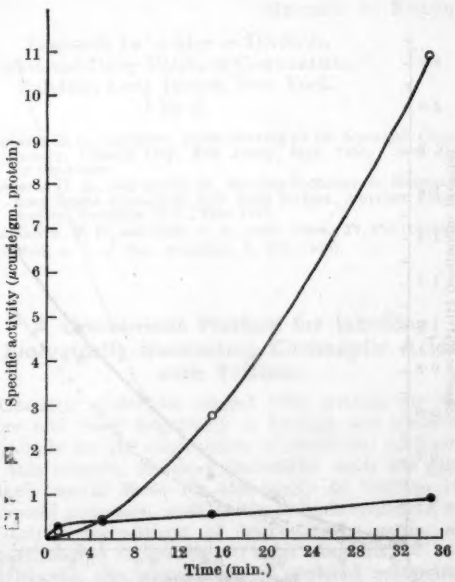


Fig. 1. Incorporation of [1-^{14}C]-glycine into the protein of cytoplasmic and membrane fractions derived from protoplasts of *B. megaterium*. The protoplasts (1 mgm./ml.) were incubated aerobically at 30° in an inorganic salts medium (*p*H 7·0) containing 0·5 *M* potassium dihydrogen phosphate and also 1 per cent glucose. After incubation for 40 min., [1-^{14}C]-glycine (0·2 μc./ml.) was added, and sampling carried out at various times as indicated in the text. ●, Membrane ; ○, cytoplasm

[1-^{14}C]-glycine was introduced, the incubation continued, and samples removed and poured on to ice after various intervals. The membrane fraction from the burst cells was sedimented and the protein precipitated with trichloroacetic acid from the sediments and from the supernatant cytoplasmic fraction. Lipids and nucleic acids were removed by the usual washing procedures, and the radioactivity of the acetone-dried protein fraction was measured. The results (see Fig. 1) show that in short periods of incubation the membrane fraction incorporates radioactivity to a greater extent, though afterwards the cytoplasmic fraction becomes more highly labelled.

The difficulty of preparing large quantities of protoplasts capable always of incorporating the amino-acids into protein at measurable rates caused us to consider a modification of the above procedure. It was then found that similar results could be obtained by reversing the order of the incorporation and lysozyme digestion stages. In this case whole cells were incubated aerobically in the usual growth medium (glucose/ammonia/salts, *p*H 7), to which the radioactive amino-acid was added and samples taken as before. After sedimentation, the chilled whole cells were resuspended in water and lysozyme added to digest the cell wall at 0°. In this way lysozyme and the less radioactive cell wall 'proteins' did reduce somewhat the radioactivity observed in the cytoplasmic fraction, but the results were qualitatively similar to those observed with protoplasts.

The deoxyribonucleic acid of the membrane fraction may be associated with some of the small spherical granules that can be seen attached to the surfaces of the cytoplasmic membranes after disruption by osmotic shock. We have found that treatment at 30° for 60 min. with 1 per cent aqueous sodium ethylenediamine tetra-acetate (*p*H 7) digests these bodies, at the same time solubilizing the deoxyribonucleic acid and some of the protein. Tracer studies were then performed as before with whole cells, but with the addition of this further fractionation procedure. The proteins from the resulting three fractions (membrane, cytoplasm, and 'deoxyribonucleic acid-protein') were then assayed, the results being shown in Fig. 2.

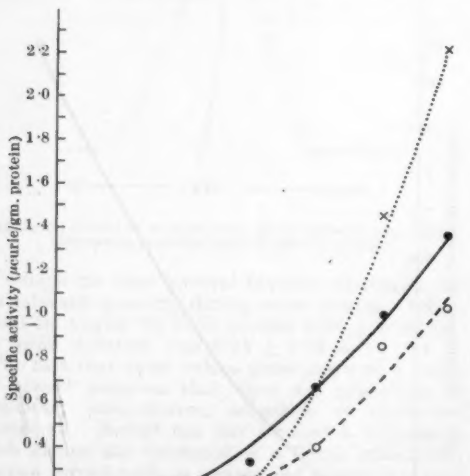


Fig. 2. Incorporation of [1-^{14}C]-glycine into the proteins of cellular fractions derived from whole cells of *B. megaterium*. The cells (5 mgm./ml.) were incubated aerobically in an inorganic salts medium (*p*H 7·0) containing 1 per cent glucose, and sampling was carried out as described in the text after the addition of [1-^{14}C]-glycine (0·06 μc./ml.). ●, Membrane; ×, cytoplasm; ○, 'deoxyribonucleic acid-protein'

These results therefore show that the initial observable incorporation of [1-^{14}C]-glycine into proteins occurs in this case in the cytoplasmic membrane. On the other hand, the protein associated with the deoxyribonucleic acid has the lowest specific radioactivity of the three fractions at all but the shortest periods of incubation, and even then is below the level found in the membrane fractions.

We thank Dr. K. V. Shooter for the ultracentrifugal analysis referred to, and Mr. R. Goodsall for his skilled technical assistance.

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

G. D. Hunter
A. R. Crathorn
J. A. V. Butler

Chester Beatty Research Institute,
Institute of Cancer Research,
Royal Cancer Hospital,
London.
June 11.

[1] Weibull, C., *J. Bact.*, **66**, 688 (1953).
[2] McQuillen, K., *Biochim. Biophys. Acta*, **17**, 382 (1955).

A Rapid Procedure for the Separation of Amino-Acids on Paper Chromatograms

In this laboratory the technique of circular paper chromatography has been modified in that small rectangular strips of filter paper are used rather than filter paper disks. This has resulted in the separation of compounds as round compact spots rather than circular bands. In addition, a combination of a horizontal solvent flow with an increase in developing temperature has resulted in a rapid increase in the mobility of the developing solvent coupled with a desirable increase in resolution.

This horizontal solvent development technique at an elevated temperature has been applied to the following analyses: (*a*) Separation of lactose from the galactosyl oligosaccharides present in lactase-hydrolysed lactose preparations in 4 hr.[1] as compared to 20–24 hr. using a conventional descending technique. (*b*) Separation of galactose and glucose (as a unit) from lactose in 2 hr.[1] as compared to 16–18 hr. using a conventional descending technique. (*c*) Separation of acetic, propionic, butyric, valeric, and caproic acids in 1 hr.[2] as compared to 20 hr. using a conventional descending technique.

The success of these rapid separations has prompted further study on the application of horizontal paper chromatography at an elevated temperature to decrease the separation time of those compounds of interest in dairy research which are separated by paper chromatography. The present communication

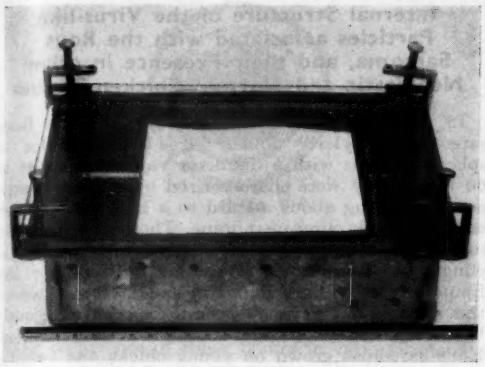


Fig. 1. The complete horizontal paper chromatographic chamber assembly in operation

presents the initial results of a study designed to develop a rapid procedure for the separation of twenty common amino-acids.

Whatman No. 1 filter paper, 12 cm. × 17 cm., is used. The origin is 2·5 cm. from one end. A 1·5-cm. tab, folded at a right angle to the paper, is inserted into the solvent trough. The opposite end of the paper is serrated using pinking shears, and a 1·0-cm. tab is folded at a right angle to the paper to permit the easy flow of solvent off the paper strip.

The chromatographic chamber measures 6 in. wide, 8 in. long, and 2 in. deep and is shown in Fig. 1. The chamber is fabricated from one piece of stainless steel, the pattern cut, and the four edges welded to form a rectangular chamber having a ¼-in. flange all around.

A stainless steel solvent trough made from one-inch diameter tubing is held in place by two brackets spot welded to each side of the chamber. The filter paper is supported in a horizontal position by means of glass rods which in turn are supported by brackets spot welded to each side of the chamber. The brackets have notches for spacing the glass rods ¼ in. apart. A sponge-rubber gasket is cemented to the flange and a glass plate cover is clamped to the flange in order to keep the chamber air-tight.

Fig. 2. Photocopy of a chromatogram after two successive 60-min. developments at 60° C. in the solvent system phenol buffered at pH 12·0: *A*, aspartic acid; *B*, glutamic acid; *C*, serine; *D*, glycine; *E*, threonine; *F*, alanine; *G*, mixture of twenty common amino-acids

Two solvent developments, each of 60 min. duration, at 60° C. using phenol buffered at *p*H 12·0[2] separate aspartic acid, glutamic acid, serine, glycine, threonine, and alanine from a mixture containing twenty common amino-acids (Fig. 2). The same separation using a descending procedure[3] requires a solvent development of 24 hr.

The amino-acid solutions containing 0·3 mgm./ml. of amino nitrogen per amino-acid (adjusted to *p*H 6·5) are applied to the filter paper (buffered at *p*H 12·0) in 0·5-microlitre volumes. The strip is then placed in the chamber which is in a 60° C. oven, the 1·5-cm. tab is inserted into the solvent trough, and solvent development occurs at 60° C. A portion of the developing solvent is also placed in the bottom of the chamber so that the atmosphere of the chamber becomes saturated with the vapours of the developing solvent.

Following the final solvent development, the chromatogram is dried for 30 min. at 60° C. in a mechanical convection oven, dipped in water-saturated butanol containing 0·4 per cent ninhydrin plus 4 per cent acetic acid, and the colour is developed[4] by placing the chromatogram in an oven at 60° C. for 15 min.

Cystine can be separated in 3 hr. using unbuffered Whatman No. 1 filter paper and butanol/acetic acid/water (25 : 6 : 25) at 60° C. (ref. 4).

In these separations it is not necessary to prepare the solvent systems at the developing temperature. The solvents were prepared at 22° C. in a temperature-controlled room prior to their use at the higher temperature.

HENRY R. ROBERTS
MICHAEL G. KOLOR

Research Laboratories Division,
National Dairy Products Corporation,
Oakdale, Long Island, New York.
May 2.

[1] Roberts, H. R., Abstracts, 130th Meeting of the American Chemical Society, Atlantic City, New Jersey, Sept. 1956. *Anal. Chem.* (in the press).
[2] Roberts, H. R., and Bucek, W., Meeting-in-Miniature, Metropolitan Long Island Subsection, New York Section, American Chemical Society, Brooklyn, N.Y., Feb. 1957.
[3] McFarren, E. F., and Mills, J. A., *Anal. Chem.*, **24**, 650 (1952).
[4] Wolwod, A. J., *J. Gen. Microbiol.*, **3**, 312 (1949).

A Convenient Method for labelling biologically interesting Carboxylic Acids with Tritium

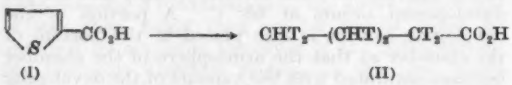
ORGANIC molecules tagged with tritium are used more and more frequently in biology and medicine, especially for the exploration of metabolic pathways. In this respect, tritiated carboxylic acids are particularly useful tools for the study of various biochemical processes, such as the dehydrogenation and oxidative degradation of higher fatty acids, and determination of the sites of such reactions.

Hitherto, the preparation of tritiated compounds involved either complicated techniques or, more recently, random exchange reactions with gaseous tritium[1]; the latter procedure, however convenient, cannot be used when molecules tagged in specific positions are required. A new method is now described, by means of which a large number of

carboxylic acids labelled with tritium in several definite positions can be very easily prepared, in good yields and with high specific activities.

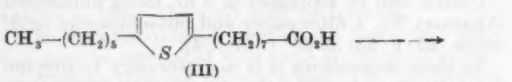
The reaction used was the reductive desulphurization of carboxylic acids of the thiophen group by means of the Raney nickel–aluminium alloy in tritiated water, the experimental procedure being the same as for ordinary hydrogenolyses[2] except that the alkali used was obtained by dissolving sodium oxide in tritiated water. The variety of labelled molecules thus obtained is demonstrated by the following examples:

Valeric acid labelled with six atoms of tritium at the α, β, γ, and δ positions (II) was obtained from 2-thenoic acid (I):

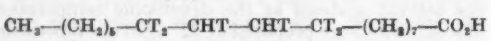


(I) (II)

Caproic acid labelled with six tritium atoms at the β, γ, δ, and ω positions was similarly obtained from 2-thienylacetic acid; stearic acid labelled at the biologically important 9, 10, 11, and 12 positions (IV), which are the sites of possible biological dehydrogenation to oleic and linoleic acid, was prepared by hydrogenolysis of the appropriate thiophen acid (III):

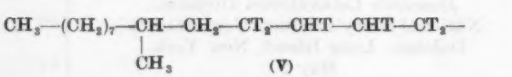


(III)

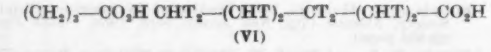


(IV)

Tritium-labelled tuberculostearic acid (V) could likewise be prepared, for use in autohistoradiographic studies[3]:



(V)



(VI)

Molecules labelled with eight tritium atoms were obtained by tritiolysis of the appropriate thiophen compounds such as β-(2-thienyl)acrylic acid, which gave œnanthoic acid (VI) labelled at all the available carbon atoms. Dicarboxylic acids could be labelled in similar manner, starting from the appropriate thiophen dicarboxylic acids[4].

Since Raney alloy desulphurizations can be applied to a wide range of organic compounds, substances having other chemical functions (alcohols, lactones, amines, amino-acids, etc.) are also susceptible to this method of labelling.

N. P. Buu-Hoï

Radium Institute,
University of Paris,
26 Rue d'Ulm, Paris V^e^.
June 9.

[1] Wilzbach, K. E., *J. Amer. Chem. Soc.*, **79**, 1013 (1957).
[2] See, for example, Sy, M., Buu-Hoï, N. P., and Xuong, N. D., *J. Chem. Soc.*, 1955 (1954).
[3] Cf. Sy, M., Buu-Hoï, N. P., and Xuong, N. D., *C.R. Acad. Sci., Paris*, **239**, 1813 (1954).
[4] Buu-Hoï, N. P., Sy, M., and Xuong, N. D., *C.R. Acad. Sci., Paris*, **240**, 442 (1955). Badger, G. M., Rodda, H., and Sasse, W., *J. Chem. Soc.*, 4162 (1954).

Internal Structure of the Virus-like Particles associated with the Rous Sarcoma, and their Presence in other Neoplastic and Normal Chicken Tissues

In ultra-thin sections of two out of three Rous sarcomas, Gaylord[1] found virus-like particles of spherical shape with a diameter varying from 45 to 60 mμ. They were characterized by a dense central core measuring about a third to a half the diameter and by a single outer membrane. These elements were mostly either isolated or in clusters outside the cells, clinging to the surface of the cell membrane; less frequently they were found in small vesicles within the cytoplasm. These observations have recently been confirmed on a larger scale comprising fifty-four Rous sarcomas grown on young chicks and twenty-one tumours grown on the chorioallantoic membrane[2]. In 41 cases of the first (76 per cent) and in 13 (62 per cent) of the second group, variable numbers of such particles were found, mostly extracellularly but also within the cytoplasm. Their size, however, was found to vary between 60 and 80 mμ. Further details concerning these findings and the reasons why they are believed to be the causative agent of the Rous sarcoma are discussed elsewhere[3].

The facts to be emphasized here are on one hand their finer structure revealed in high-resolution electron micrographs, and on the other, their occurrence in various other chicken tissues. Upon close examination, it was found that they have not one but two distinct membranes (Fig. 1): an outer one which surrounds the particle and an inner one enclosing an apparently transparent zone around a dense central core. This 'nucleoid' measures between 30 and 40 mμ (Fig. 2). The existence of two membranes might appear a minor detail at first. The importance of such an ultrastructure, however, lies in the fact that it puts the particles in line with known virus bodies of a somewhat similar ultrastructure which corresponds to a definite phase of their evolution.

By analogy with the Bittner virus, where the outer viral membrane is formed by a very small portion of the cell membrane at the moment when the virus body segregates itself from the cell from which it originates[3], one might assume that a comparable mechanism exists here. This view would give a morphological basis for a theoretical concept reached as a conclusion to all the complicated and conflicting data concerning Rous sarcoma virus, which is the presence of two antigens (Harris[4], and Oberling and Guérin[5]). The host antigen may thus be located at the peripheral structure of the particle.

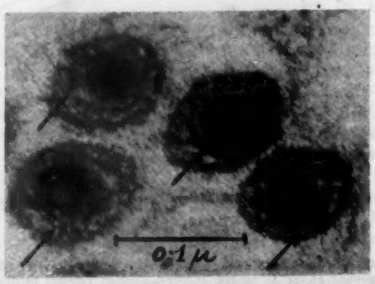


Fig. 1

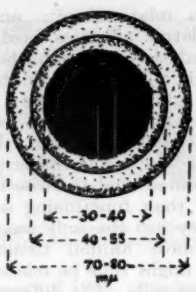


Fig. 2

The occurrence of these bodies in various amounts in other chicken neoplasms such as the Murray-Begg tumour[6], the erythroblastosis[7] and their presence even in normal young chickens[7] is an important fact, but for the moment its interpretation remains hypothetical: there may exist either an inactive ubiquitous agent in all chicken tissues which can become differentiated and oncogenic in an appropriate environment; or, the particles in normal controls could represent the widespread lymphomatosis virus, although the strains used for this study were clinically free of this disease.

CH. OBERLING
W. BERNHARD
PH. VIGIER

Institut de Recherches sur le
Cancer Gustave Roussy,
Villejuif, Seine.
March 30.

[1] Gaylord, W. H., *Cancer Res.*, **15**, 80 (1955).
[2] Bernhard, W., Oberling, Ch., and Vigier, Ph., *Bull. Cancer*, **43**, No. 4 (1956).
[3] Bernhard, W., Guérin, M., and Oberling, Ch., *Acta int. contra Cancrum*, **12**, Nos. 5–6, 544 (1956).
[4] Harris, R. J. C., Report of the Royal Cancer Hosp., 1955, p. 33.
[5] Oberling, Ch., and Guérin, M., "Advances in Cancer Research" (1955).
[6] Rouiller, Ch., Haguenau, F., Goldé, A., and Lacour, F., *Bull. Cancer*, **43**, No. 10–22 (1956).
[7] Benedetti, E. L., Bernhard, W., and Oberling, Ch., *C.R. Acad. Sci., Paris*, **242**, 2891 (1956).

Intestinal Lecithinase

Schmidt, Bessman and Thannhauser[1] described a phospholipase in mitochondria of rat intestinal mucosa which is highly active towards cephalin but relatively inactive towards lecithin. A possible explanation of this lack of activity towards lecithin was found in our studies of a similar enzyme preparation from rat intestine. It was found that the breakdown of lecithin to glycerophosphorylcholine depends on the concentration of enzyme used (see Fig. 1, (I)–(III)). With low enzyme concentrations a considerable lag period was observed followed by an autocatalytic rate of reaction. The lag period could be abolished by the addition of degradation products of lecithin, fatty acids (palmitic, oleic, stearic) and lysolecithin.

It seems likely that the presence of fatty acids is obligatory for lecithinolysis. Small amounts of fatty acids (6 μgm./ml.) were found to be present in the enzyme preparations. Lysolecithin also furnishes fatty acids due to the active lysolecithinase present. Similarly, the activation by cephalin reported by

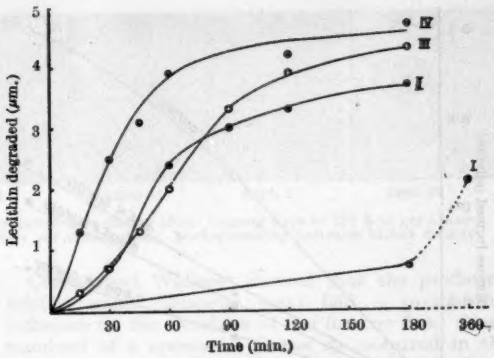


Fig. 1. (I) With 0·3 ml. enzyme; (II) with 0·3 ml. enzyme plus 4 μgm. palmitic acid; (III) with 0·6 ml. enzyme; (IV) with 0·6 ml. enzyme plus 4 μgm. palmitic acid.

Rat intestinal mucosa was ground with equal weight of sand, extracted with water (2 ml./gm. mucosa) and centrifuged at 800*g* at 4° C. The supernatant was brought to *p*H 5·5 with 0·1 *N* acetic acid and the precipitate was resuspended in 0·02 *M* phosphate buffer *p*H 6 (2 ml./gm. of original tissue weight). 5 μgm. egg lecithin (ref. 3)+40 μgm. phosphate buffer *p*H 6 with the indicated enzyme amounts made up to 1 ml. was incubated at 37° C. The rate of the reaction was determined by following the decrease in ester content according to Stern and Shapiro (ref. 4)

Schmidt *et al.*[1] may be due to the fatty acids liberated from this substrate.

The intestinal lecithinase described differs from generally known lecithinases[2], being bound to particles and inhibited by Ca^{++} at 20 μgm./ml. and Cd^{++} 0·5 μgm./ml. as well as by cholic acid. Lecithinase activity could not be separated from lysolecithinase by any purification procedure so far tried.

B. EPSTEIN
B. SHAPIRO

Department of Biochemistry,
Hebrew University–Hadassah Medical School,
Jerusalem, Israel.
April 1.

[1] Schmidt, G., Bessman, M. J., and Thannhauser, S. J., *Biochim. Biophys. Acta*, **23**, 127 (1957).
[2] Hayaishi, O., and Kornberg, A., *J. Biol. Chem.*, **206**, 647 (1954). Chargaff, E., and Cohen, S. S., *ibid.*, **129**, 619 (1939). Contardi, A., and Latzer, P., *Biochem. Z.*, **197**, 222 (1928).
[3] Pangborn, M. C., *J. Biol. Chem.*, **188**, 471 (1951).
[4] Stern, I., and Shapiro, B., *J. Clin. Pathol.*, **6**, 158 (1953).

Sensitivity of Pancreas Hexokinase towards Alloxan and its Modification by Glucose

THE administration of glucose, mannose or fructose, but not galactose or several other sugars tested, can prevent the effect of a normally diabetogenic dose of alloxan. This protection was found by Bhattacharya[1,2] in the rat. From the relative efficiencies of these sugars he concluded that the diabetogenic action of alloxan could depend on an inactivation of the hexokinase of the beta cells of the pancreas. Arteta and co-workers have confirmed the protective effect of glucose in the dog[3]. They have also observed that insulin[3] and floridzin[4] can increase, and adrenalin[5] and glucagon[6] can decrease, the sensitivity towards alloxan, apparently in relation to their effect on the blood sugar-level. The work described here on the effect of alloxan on pancreas hexokinase *in vitro* does not support the hexokinase inhibition theory of alloxan action.

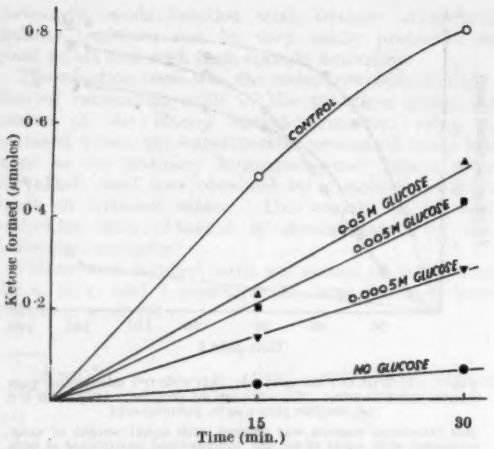


Fig. 1. Effect of the concentration of glucose on the protection of pancreas hexokinase against inactivation by alloxan. The buffered enzyme, with glucose at final concentrations as indicated, was incubated with 0·004 *M* alloxan (except the control) for 5 min. Residual hexokinase activity was then estimated by the total ketose formation method, carrying out incubations of 15 min. and 30 min. for each kind of pretreated sample

Experiments were carried out with a partially purified preparation of dog pancreas hexokinase (Villar-Palasí, C., unpublished work). Assay of hexokinase activity was carried out with glucose as substrate by the method of substrate disappearance[7] or the ketose ester formation method[8]. The latter was modified by the addition of a large excess of phosphoglucose isomerase and phosphofructokinase; total ketose was estimated on trichloroacetic acid filtrates by the cysteine–carbazol method[9]. The incubation mixtures were strongly buffered (0·2 *M* phosphate, *p*H 7·5) to prevent any marked changes when alloxan was added.

Incubation of the buffered enzyme with 0·004 *M* alloxan for 5 min. at 30° C. resulted in 93 per cent inactivation of the enzyme. Sensitivity of a hexokinase towards alloxan had been previously observed in muscle extracts[10]. In the presence of 0·005 *M* glucose the inactivation was only 58 per cent. With glucose at this concentration doses of 3, 2, 1 and 0·5 micromoles of alloxan per ml. produced inhibitions of 53, 40, 30 and 25 per cent respectively. Fig. 1 shows the effect of drastic changes in the concentration of glucose above and below that corresponding to the normal blood sugar value. It also illustrates the fact that five minutes after the addition of the alloxan the inactivation of hexokinase has levelled off. Since the K_m of the enzyme for glucose is 1×10^{-5} *M* (Villar-Palasí, C., unpublished work), the non-competitive partial prevention of alloxan inhibition by glucose may be interpreted as a result of the masking of the active centre by a substrate which thus hinders the inactivation by the —SH reagent.

The small differences in the degree of protection conferred by the different concentrations of glucose are out of proportion with the close relationship between blood glucose and sensitivity towards alloxan[2–6]. Moreover, Bhattacharya[2] has reported that the relative protective abilities are glucose : mannose : fructose = 100 : 50 : 15, "which closely simulate their relative affinities to the ordinary mammalian hexokinase". In fact no known animal hexokinase approaches such relationship[7]; and that of dog pancreas has relative affinities as different as 100 : 100 : 1 (Villar-Palasí, C., unpublished work).

Thus, although alloxan can inhibit the pancreas hexokinase, and glucose can afford some degree of protection, there appears to be no real basis for the hexokinase inhibition theory of the diabetogenic action of alloxan. We would rather point to the fact that glucose, mannose and fructose have in common something more than functioning as substrates for hexokinase: they are the only sugars that can be glycolysed by most animal tissues. Sensitivity towards alloxan might thus be related to the energy supply of the beta-cells. The differences observed in the efficiency of these three sugars *in vivo* may well be related to differences in their transport across the cell membrane.

C. Villar-Palasi
A. Carballido
A. Sols
J. L. Arteta

Department of Enzymology,
and
Institute of Experimental Endocrinology,
Centro Cajal de Investigaciones Biológicas,
Madrid.
April 27.

[1] Sen, P. B., and Bhattacharya, G., *Indian J. Physiol. and Allied Sci.*, **6**, 112 (1952). Bhattacharya, G., *Science*, **117**, 230 (1953).
[2] Bhattacharya, G., *Science*, **120**, 841 (1954).
[3] Arteta, J. L., König, C., and Carballido, A., *J. Endocrin.*, **10**, 342 (1954).
[4] Arteta, J. L., and Carballido, A., *Rev. Ibérica Endocrin.*, **3**, 305 (1956).
[5] Arteta, J. L., and Carballido, A., *J. Endocrin.*, **14**, 234 (1956).
[6] Arteta, J. L., and Carballido, A., *J. Endocrin.* (in the press).
[7] Crane, R. K., and Sols, A., in S. P. Colowick and N. O. Kaplan's "Methods in Enzymology", **1**, 277 (Academic Press, New York, 1955).
[8] Sols, A., *Biochim. Biophys. Acta*, **19**, 144 (1956).
[9] Dische, Z., and Borenfreund, E., *J. Biol. Chem.*, **192**, 583 (1951).
[10] Griffiths, M., *Arch. Biochem.*, **20**, 451 (1949).

Field Evidence of Density-governing Reaction in *Sminthurus viridis* (L.)

The limits of distribution of the lucerne flea in Western Australia are determined primarily by rainfall and temperature[1]. Thus the infested area is restricted to a comparatively small section in the south-west corner of the State, where the occurrence of the active stages of the insect is determined primarily by favourable conditions of rainfall and temperature. In most places the high temperatures and low rainfall of the summer period cause the active stages to disappear completely, continuity of the species being maintained by the highly resistant æstivating eggs.

The population fluctuations caused by changes in temperature and rainfall can be easily observed and demonstrated[1,2]. However, when comparatively small areas are examined closely, local population variations are observed which bear no relation whatever to the prevailing moisture and temperature conditions.

In order to study these latter variations, an area ten chains square, mostly under *Medicago* and *Hordeum* spp., was selected in September 1952. Permanent sampling sites were established by placing pegs at the points of intersection of grid lines drawn over the area. After the hatching of the æstivating

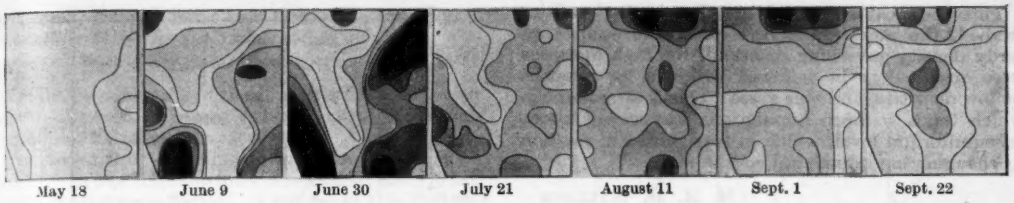


Fig. 1. Maps showing changes in distribution of *S. viridis* in observed area during 1953. Contour lines at 133 fleas per square link, except within unshaded areas where the line represents 66 fleas per square link. Darker shading indicates higher density

eggs in the autumn of 1953, population samples were collected every three weeks from the area within about five yards of each peg. The population density of *S. viridis* at each peg on each sampling date was thus obtained, and maps were drawn to show the pattern of numerical distribution at regular intervals throughout the season (Fig. 1).

The general inverse relation between the population density of lucerne fleas at any particular point at the beginning of the season and the density at the same point towards the end of the active season is shown clearly in these maps, and also in Fig. 2. Similar trends are shown by data obtained from the same area in subsequent years and from another study area in a distant locality.

Evidence has been gathered which shows that this changing mosaic of densities is not caused by mass movement of the lucerne fleas from areas of high to areas of low population density. The distances to be covered are too great and, at the most, some minor intermingling of the insects from neighbouring sampling sites may take place towards the end of the season. Therefore, the changes in the mosaic must be brought about by local differences in birth-rate or survival, or in both.

Examination of Fig. 2 shows that where densities exceeded approximately 20 per square link in May they had decreased by September, and where they were below this figure in May they had increased, there being only a few minor departures from this relation. Also, in general, the greater the departure from 20 in May, the greater was the departure, of opposite sign, in September. (This figure of 20 fleas per square link applies, of course, only to the data presented and may vary considerably according to the actual time of sampling and prevailing environmental conditions.) The coefficient of correlation between the estimated initial and final population densities of fleas was $-0{\cdot}426$ (significant at $P < 0{\cdot}001$). Statistically significant negative correlations were also obtained for the next three seasons (1954–56). This clear-cut and consistent relation between absolute density-levels strongly implies that the changes in density recorded at each observation point were due largely to some factor influenced by population density.

Preliminary field experiments have provided direct evidence of density-induced governing reaction, for they show that, in areas where the insect was abundant, fertility was reduced, and mortality was considerably increased. This is consistent with the laboratory experiments made with *S. viridis* by Maclagan[3]. It has not yet been determined whether these variations in fertility and mortality related to density are caused directly by interference between overcrowded individuals, or indirectly through the depletion of the environment or its impairment in other ways.

Currie[4] and Wallace[5] showed that the predatory bdellid mites (*Biscirus* spp.) had a pronounced influence on the numbers of the lucerne flea. Small numbers of a species of *Scirus* sp. occurred in the study area, but the distribution of this predator was at no time correlated with flea distribution, and later observations have shown that changes in lucerne flea numbers similar to those described above occur when the bdellid mite is eliminated by a selective insecticide.

It might be argued that small-scale variations in topography which could influence moisture, such as a mosaic of soil types or of ridges and hollows, might cause environmental favourability to decrease in some areas and to increase in others during the course of a season. Observations over four successive years, however, showed that the density mosaic patterns were very different each year, and so could not be related to any underlying topographical pattern. Also, if changes in environmental favourability were independent of density, the points in Fig. 2 would have been more or less randomly scattered. Furthermore, it is inconceivable that temporary local variations in weather conditions could have produced the observed changes in the density mosaic within such very small areas as those studied. The conclusion is inescapable that variations in the physical environment independent of density of population cannot be the cause of the inverse density relationship observed.

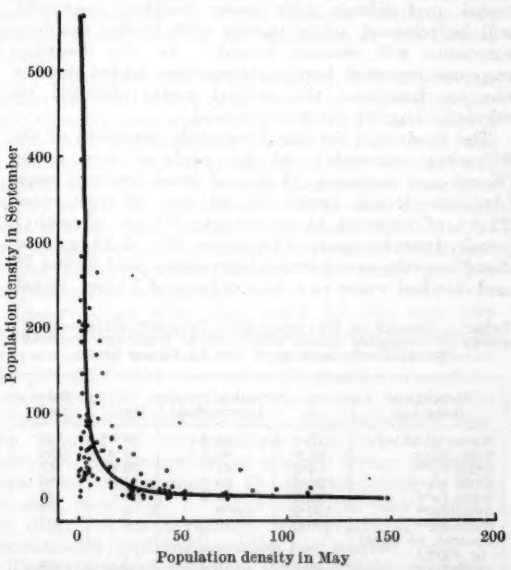


Fig. 2. Relation between density of *S. viridis* at given points early in the 1953 season and density at the same points later in the season

Thus there can be little doubt that, in the localities studied, the numbers of *S. viridis* were subject to tardy density-governing reaction[6], for high densities were observed to be followed within a few months by low densities, and vice versa. This is a mechanism which tends to keep populations fluctuating about an equilibrium level, which in turn varies in relation to changing environmental conditions[6].

M. M. H. Wallace

Division of Entomology,
Commonwealth Scientific and
Industrial Research Organization,
Western Australian Regional Laboratory,
Nedlands, Western Australia.
April 16.

[1] Davidson, J., Coun. Sci. Indust. Res. Aust. Bull. No. 79 (1934).
[2] Norris, K. R., Coun. Sci. Indust. Res. Aust. Pamphlet No. 84 (1938). Holdaway, F. G., Coun. Sci. Indust. Res. Aust. Pamphlet No. 4 (1927).
[3] Maclagan, D. S., *Bull. Ent. Res.*, **23**, 101 (1932).
[4] Currie, G. A., *J. Coun. Sci. Indust. Res. Aust.*, **7**, 9 (1933).
[5] Wallace, M. M. H., *Aust. J. Agric. Res.*, **5**, 148 (1954).
[6] Nicholson, A. J., *Aust. J. Zool.*, **1**, 9 (1954).

Dwarf *Drosophila* produced by Ethylene Diamine Tetra-acetic Acid: a Relationship to Chelation of Zinc

Many chemical and physical treatments have been used for producing non-heritable changes in development. When such changes resemble known mutants, they are called phenocopies. A variety of phenocopies has been induced by metals or metal-inhibiting compounds[1].

In a strain of *Drosophila melanogaster*, dwarf or midget phenocopies were caused by a metal-complexing or chelating agent, ethylene diamine tetra-acetic acid (EDTA). The portions of a metal which are bound or free depend directly on the stability constant of that ion[2]. Hence, if a metal ion is added to food with ethylene diamine tetra-acetic acid, that metal, and metals with lower stability constants, will be released, while metals with higher stability constants will remain bound. In the dwarfing response reported here, cations were added one by one to determine the critical metal chelated by ethylene diamine tetra-acetic acid.

The food used for the *Drosophila* consisted of the following materials: 55 ml. each of corn syrup (Karo) and molasses, 22 gm. of dried brewer's yeast (Anheuser-Busch strain *G*), 88 gm. of corn meal, 22 gm. of oat meal, 11 gm. of agar, 2·7 gm. of methyl-parahydroxybenzoate (Tegosept *M*), 2·23 gm. of disodium ethylene diamine tetra-acetic acid (0·006 *M*) and distilled water to a final volume of 1 litre. Metals were added to the media at the molarities indicated in Table 1 and Fig. 1. All media for the growth of flies were autoclaved.

Table 1. Degree of Dwarfing when Divalent Metals were added to *Drosophila* Media with 0·006 *M* Ethylene Diamine Tetra-acetic Acid using the 3*A* Dwarf Stock

Molarity of metal ion	Percent of females			Total females
	+	Intermediate	Dwarf	
No metal added	17·7	56·2	26·0*	192
0·005 Mg^{2+}	43·6	36·5	19·9	156
0·005 Ca^{2+}	8·2	61·2	30·6	49
0·005 Mn^{2+}	26·3	49·7	24·0	886
0·005 Fe^{2+}	52·1	34·2	13·7	73
0·005 Co^{2+}	100·0	0	0	416
0·005 Zn^{2+}	100·0	0	0	923
Control, no metal or EDTA added	99·8	0·2	0	478

* Means from different experiments average about 30 per cent ± 5

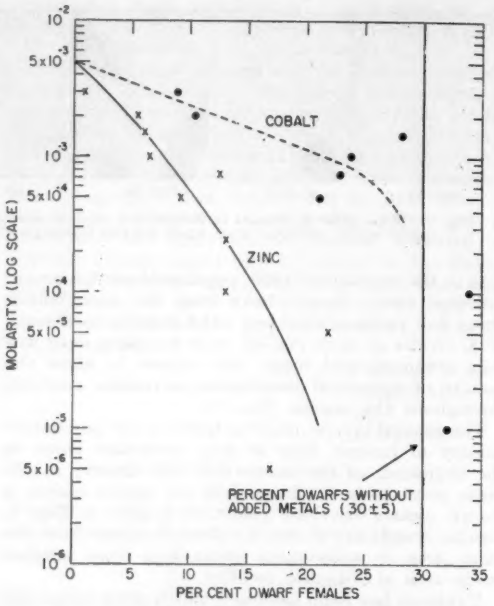


Fig. 1. Zinc or cobalt was added to *Drosophila* media containing 0·006 *M* ethylene diamine tetra-acetic acid

In the dwarfing experiments only females were scored. The length from head to wing tip was used as a criterion. The following classes were arbitrarily established using the maximum length of normally grown Oregon *R* as standard wild type. Dwarfs were a half to two-thirds the length of wild type, intermediates were longer than two-thirds but not exceeding three-quarters; and 'wild type' as used in Table 1 was longer than three-quarters. The *Drosophila melanogaster* stock, 3*A* dwarf, which was used originated from selected F_2 progeny of Oregon *R* wild type mated to a stock with the sex-linked genes yellow, cut, raspberry and forked.

When pairs of dwarfs were grown on standard food without ethylene diamine tetra-acetic acid they were usually fertile and had progeny indistinguishable in length from wild type. As seen in Table 1, dwarf females developed on the medium containing ethylene diamine tetra-acetic acid when no metals were added, or when divalent magnesium, calcium, manganous or ferrous ions were added separately. However, the addition of cobaltous or zinc ions completely prevented dwarfing.

Cobaltous and zinc ions have stability constants which are nearly the same ($Co^{2+} = 16{\cdot}10$ and $Zn^{2+} = 16{\cdot}15$)[3]. If competition for ethylene diamine tetra-acetic acid is to be demonstrated, ion concentrations lower than 0·005 *M* should be used. Theoretically, the dwarfing response of zinc and cobalt would then be distinguishable. As shown in Fig. 1, cobalt had no effect in preventing dwarfing at 1×10^{-4} *M* or less, while zinc at 5×10^{-6} *M* gave less dwarfing than the 30 ± 5 per cent value from ethylene diamine tetra-acetic acid media without metals added. Presumably, cobalt from 5×10^{-5} to 5×10^{-4} *M* could compete with zinc for ethylene diamine tetra-

acetic acid, leaving some zinc free. The prevention of dwarfing followed the metal series,

$$Mg^{2+} < Ca^{2+} < Mn^{2+} < Fe^{2+} < Co^{2+} < Zn^{2+}$$

The stability constants of these metals have the same order[3,4]. Zinc was apparently the critical metal bound by ethylene diamine tetra-acetic acid.

The period from hatching to pupation was lengthened by ethylene diamine tetra-acetic acid, and varied directly with concentration. A release of this growth inhibition was accomplished by adding metals. The degree of effectiveness was the same as above. With zinc there was no growth retardation. Other findings of these experiments, to be published elsewhere, were: (1) selective advantages for different genotypes; (2) changes of sex ratio in both directions[4]; and (3) an autosomal inheritance for degrees of penetrance of the dwarf phenocopies.

Recently, ethylene diamine tetra-acetic acid has been used to increase the frequency of genetic recombination[5], and to enhance X-ray-induced chromosome breakage[6]. Some authors have assumed that ethylene diamine tetra-acetic acid chelated primarily calcium or magnesium. The *Drosophila* experiments presented here indicate that zinc, ferrous iron, manganese and other heavy metals are bound by ethylene diamine tetra-acetic acid before calcium and magnesium. Discussions concerning a mechanism for these effects on chromosomes should await further study.

DALE STEFFENSEN

Biology Department,
Brookhaven National Laboratory,
Upton, Long Island,
New York.
April 24.

[1] Rapoport, J. A., *Amer. Nat.*, **81**, 30 (1947). Goldschmidt, R. B., and Piternick, L. K., *Proc. U.S. Nat. Acad. Sci.*, **42**, 299 (1956).
[2] Martell, A. E., and Calvin, M., "Chemistry of the Metal Chelate Compounds" (Prentice-Hall Inc., New York, 1952).
[3] Schwarzenbach, H., and Freitag, E., *Helv. Chim. Acta*, **34**, 1492 (1951).
[4] Schwarzenbach, G., and Ackermann, H., *Helv. Chim. Acta*, **30**, 1798 (1947).
[5] Levine, R. P., *Proc. U.S. Nat. Acad. Sci.*, **41**, 727 (1955). Eversole, R. A., and Tatum, E. L., *ibid.*, **42**, 68 (1956). Steffensen, D., Anderson, L. F., and Kase, S., *Genetics*, **41**, 663 (1956).
[6] Wolff, S., and Luippold, H. E., *Proc. U.S. Nat. Acad. Sci.*, **42**, 510 (1956).

Polymorphism in Human Trypanosomiasis

THERE are different theories about the significance of polymorphism in trypanosomes of the *brucei* group. According to Robertson[1], stumpy forms elongate into slender forms, which divide, giving rise again to stumpy forms. Fairbairn and Culwick[2] separated slender, intermediate and stumpy forms as three distinct entities, which they believed were produced by the sexual process of syngamy.

The present investigation was started in East Africa in 1955, using both a syringe-passaged and a fresh *T. rhodesiense* strain; in 1957 the work was continued in West Africa, using a cyclically transmitted strain of *T. gambiense*. It has been found that the number of trypanosomes in the blood of the mammalian host fluctuates more or less cyclically, and that the percentage of stumpy forms is lowest when parasitæmia is increasing and highest when it is decreasing. It was often impossible to differentiate between slender and intermediate and between intermediate and stumpy forms; such forms Hoare[3] refers to as transitional.

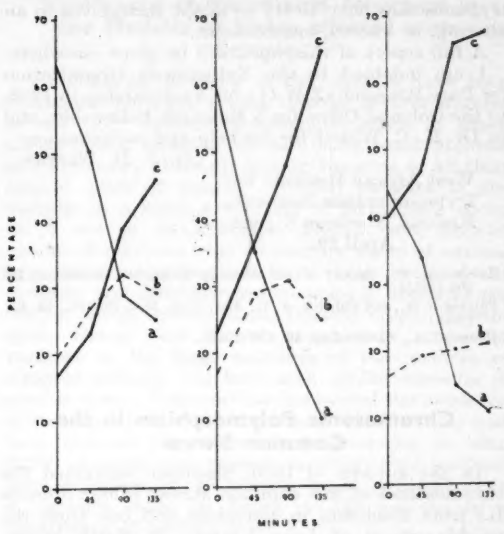


Fig. 1. (*a*), Slender forms; (*b*), intermediate forms; (*c*), stumpy forms

In the West African experiment with *T. gambiense* the white blood cells were also counted and differentiated. It was observed that a fall in parasitæmia was very often associated with a great increase in the lymphocytes in the blood.

From these observations it was concluded that the periodic decrease in parasitæmia is caused by the protective reactions of the host's body, and that the factor which causes this drop in trypanosome numbers is also responsible for the production of stumpy forms.

The common occurrence of transitional forms suggested that intermediate and stumpy forms are not produced by a sexual process between two slender forms, but by the shrinkage of the slender forms.

To investigate this last possibility, a *T. rhodesiense* strain was used which had been transmitted cyclically through rats since 1953. In order to obtain a fairly high percentage of slender forms, blood was taken during a rise in parasitæmia and 0·5 cm.^{3} was mixed with 1 cm.^{3} of human plasma and kept in a bottle at 37° C. At intervals of 45 min. the bottle was shaken, thin slides were made, the ratio of trypanosomes to erythrocytes was ascertained, and a morphological differentiation was made for 200 trypanosomes in each slide.

Observations were only valid for the first two hours of this experiment, because after that time the trypanosomes started to degenerate. Throughout the period of valid observation the number of erythrocytes remained approximately constant, as did the trypanosome–erythrocyte ratio, thus indicating that the number of trypanosomes did not decrease; however, the proportion of stumpy forms increased greatly at the expense of the slender forms, as will be seen from Fig. 1. Agglomeration, which could be described as syngamy, was practically never encountered until degeneration had started.

This experiment, therefore, makes it highly probable that stumpy forms are produced by the shrinkage of slender forms in circumstances in which the

trypanosomes have to try to adapt themselves to an altering, or altered, environment.

A full report of this work will be given elsewhere.

I am indebted to the Netherlands Organization for Pure Research (Z.W.O.) for a scholarship in 1955, to the Colonial Office for a Research Fellowship, and to Dr. K. C. Willett for his help and co-operation.

D. J. B. Wijers

West African Institute for Trypanosomiasis Research, Kaduna, Northern Nigeria.

April 29.

[1] Robertson, M., Report of the Sleeping Sickness Commission, **13** 104 (1913).

[2] Fairbairn, H., and Culwick, A. T., *Ann. Trop. Med. Parasit.*, **40**, 421 (1946).

[3] Hoare, C. A., *Parasitology*, **46**, 130 (1956).

Chromosome Polymorphism in the Common Shrew

In the autumn of 1955, Sharman[1] examined the chromosomes of five common shrews (*Sorex araneus* L.) from Buckland in Berkshire and one from the neighbourhood of Lake Vyrnwy in North Wales. He confirmed Bovey's[2] report that there are three sex chromosomes in the male, and made the surprising observation that the diploid number of chromosomes varied from 22 to 25 in different individuals. It appeared that some chromosomal elements could be present in either of two forms: as single V- or J-shaped (metacentric) chromosomes, or as pairs of rod-shaped (acrocentric) chromosomes, one rod corresponding to each arm of the V or J. The total number of autosome arms was therefore constant. This type of chromosome polymorphism is fairly well known in invertebrates, instances having been reported in several species of the Acrididae[3] and Coleoptera[4], in mantids[5], and in a mollusc[6]. A similar system may exist in the lizard, *Gerrhonotus scincicauda*[7], and in mammals an apparent case involving a single metacentric chromosome pair has recently been discovered in the rodent species *Gerbillus pyramidum* by Wahrmann and Zahavi[8].

In the summer of 1956, fifty more shrews were trapped, 44 of them on the grassy edges of a small thicket at Chilton, Berkshire, and the remainder less than a quarter of a mile away. Feulgen squash preparations of bone marrow and/or spleen and/or testis were made following pretreatment methods described elsewhere[9]. The results confirm and extend the findings of the previous autumn: the chromosome number was found to be constant within individuals but to vary from 22 to 27 in different males and from 22 to 25 in different females. The number of autosomal arms was constantly 36.

The chromosomes of two individuals are shown in Figs. 1 and 2, and diagrammatically in Fig. 3. Pairs of each of the normal autosomes (Nos. 1, 2, 3, 4, 5 and 9 in the diagram) were present in all the individuals examined. Apart from Nos. 3 and 4, which differ only slightly in size and have median centromeres, they are readily distinguished. The variable elements are Nos. 6, 7 and 8, each of which may be represented by a single metacentric chromosome or by two acrocentric chromosomes. J-shaped element 6 is easily identified. V-shaped elements 7 and 8 are not difficult to distinguish when both are present in the same cell (as in Fig. 1); but when one type alone is present photographs and measurements may be necessary for positive identification. Of the derivative rods, only that corresponding to the longer arm of metacentric element 6 can be identified with certainty. The interpretation here given is supported by the observation of the expected trivalent associations in stages from diplotene to metaphase in primary spermatocytes.

Fig. 1. Colchicine metaphase from spleen of shrew 35 (male). × 1,460

Fig. 2. Colchicine metaphase from spleen of shrew 39 (female). × 1,220

Each of the element pairs 6, 7 and 8 has now been observed (in different individuals) in three states, namely, as two metacentric, as one metacentric and two acrocentric, or as four acrocentric chromosomes. Theoretically, therefore, there should be $3^3 = 27$ cytological types possible. Fifteen of these have been identified.

Such a situation is formally equivalent to a polymorphic system with alternative genes at each of three loci, and comparison of the observed numbers of individuals of the different cytological types with those expected on the basis of the Hardy–Weinberg ratio is suggested. It was possible to define the chromosome set completely in 42 of the 50 individuals examined and these are classified and tested against expectation in Table 1. There is a small excess of heterozygotes for chromosome 6 and small deficiencies of heterozygotes for the other two chromosomes concerned, but the numbers are too small for a test of significance.

The common shrew is widely distributed in Europe and is evidently adapted to a diversity of ecological conditions[10]. At present we can only be certain that the polymorphic chromosome system we have de-

Table 1. Common Shrew (*Sorex araneus*): 42 Individuals trapped in 1956. Observed Numbers of 27 Cytological Types and Numbers expected on the Hardy–Weinberg Relation

(*M* = homozygous metacentric; *HET* = heterozygous; *A* = homozygous acrocentric)

		Chromosome 6								
		M			*HET*			*A*		
Chromosome 7		*M*	*HET*	*A*	*M*	*HET*	*A*	*M*	*HET*	*A*
Chromosome 8	*M*	$\frac{-}{0\cdot080}$	$\frac{-}{0\cdot227}$	$\frac{-}{0\cdot168}$	$\frac{1}{0\cdot281}$	$\frac{2}{0\cdot827}$	$\frac{-}{0\cdot609}$	$\frac{2}{0\cdot252}$	$\frac{-}{0\cdot743}$	$\frac{-}{0\cdot546}$
	HET	$\frac{-}{0\cdot365}$	$\frac{-}{1\cdot075}$	$\frac{-}{0\cdot790}$	$\frac{1}{1\cdot319}$	$\frac{5}{3\cdot885}$	$\frac{3}{2\cdot852}$	$\frac{1}{1\cdot189}$	$\frac{5}{3\cdot494}$	$\frac{-}{2\cdot566}$
	A	$\frac{-}{0\cdot428}$	$\frac{-}{1\cdot264}$	$\frac{3}{0\cdot928}$	$\frac{1}{1\cdot554}$	$\frac{4}{4\cdot570}$	$\frac{7}{3\cdot356}$	$\frac{2}{1\cdot399}$	$\frac{2}{4\cdot112}$	$\frac{3}{3\cdot020}$

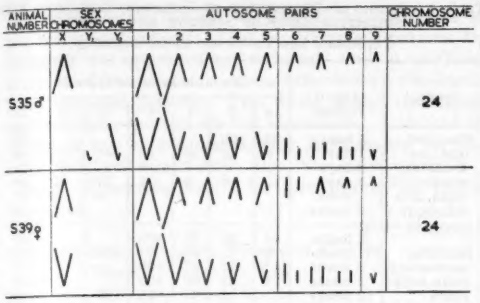


Fig. 3. Diagram showing chromosome constitution of shrews 35 and 39

scribed exists within the county of Berkshire, since the Lake Vyrnwy specimen was a homozygote, and Bovey[2], the only previous authority, reported on two (Swiss) males only, both of which were evidently homozygotes. It may be assumed that the system is maintained because some of the cytological types have a selective advantage over others, but at present the details of this operation must remain largely conjectural. Significant deviation from the Hardy–Weinberg proportions might be in the direction either of an excess, or of a deficiency, of heterozygous types. An excess of heterozygotes could be attributed either to a direct selective advantage of the heterozygotes or to an assortative mating system favouring outbreeding. A deficiency of heterozygotes might be due to balanced advantages of the homozygous types or to inbreeding. Now the powers of dispersal of small mammals like the shrew are likely to be limited, so that a significant degree of inbreeding may well occur. Should this be combined with a selective advantage of heterozygotes, it would be possible for a situation to arise in which there was a spurious agreement with the Hardy–Weinberg ratio. It is therefore clear that a full analysis of the operation of the system of chromosome polymorphism in the shrew will not be possible without reliable information about the size and density of wild shrew populations and of the range of movement of single animals. Such information, combined with cytological study of samples of adults and of litters of embryos *in utero*, could help considerably towards an understanding of the genetical population structure of a common small mammal.

C. E. Ford
J. L. Hamerton*
G. B. Sharman†

Medical Research Council
Radiobiological Research Unit,
Atomic Energy Research Establishment,
Harwell, Berkshire. May 30.

* Present address: British Museum (Natural History), South Kensington, London, S.W.7.

† Present address: Department of Zoology, University of Adelaide, Adelaide, South Australia.

[1] Sharman, G. B., *Nature*, **177**, 941 (1956).
[2] Bovey, R., *Rev. suisse Zool.*, **56**, 371 (1949).
[3] White, M. J. D., "Animal Cytology and Evolution" (2nd edit., Camb. Univ. Press, 1954).
[4] Smith, S. G., *Experientia*, **12**, 52 (1956); *Nature*, **177**, 386 (1956).
[5] Wahrman, J., *Experientia*, **10**, 176 (1954).
[6] Staiger, H., *Atti del IX Congresso Internationale di Genetica*, 892 (1956); *Chromosoma*, **6**, (1956).
[7] Matthey, R., "Les Chromosomes de Vertèbres" (F. Rouge, Lausanne, 1949).
[8] Wahrman, J., and Zahavi, A., *Nature*, **175**, 600 (1955).
[9] Ford, C. E., and Hamerton, J. L., *Stain Tech.*, **31**, 247 (1956).
[10] Steven, D. M., *J. Anim. Ecol.*, **24**, 403 (1956).

Significance of Vacuolated Neurones in the Medulla of Sheep affected with Scrapie

Vacuolated neurones in the medulla have been considered for quite a long time by several workers as the only constant microscopic lesion in sheep affected with scrapie. On the other hand, Holman and Pattison[1], although finding vacuoles in all their clinical cases of scrapie, reported vacuoles in the medulla in a small proportion of non-scrapie sheep (in 5 out of 98 animals). Zlotnik and Rennie[2] examined material from 57 healthy sheep of various ages using serial sections from three levels of the medulla, and demonstrated vacuoles in about 73 per cent of sheep, mainly of the Cheviot breed. Bosanquet, Daniel and Parry[3] found only occasional vacuoles in the large neurones of the medulla of scrapied animals, but have seen similar vacuoles in normal sheep. Pattison[4] has discovered the incidence of vacuolated neurones in goats in which scrapie had been induced experimentally. According to him, 2,279 vacuoles were present in ninety-four sections, from medullas of 16 scrapie goats, whereas only 8 vacuoles could be found in 592 sections from medullas of 16 healthy goats.

In the present study two groups of sheep have been examined, one group consisting of ten animals in advanced stages of clinical natural scrapie and the other group being composed of ten healthy animals of ages comparable to those of the scrapie animals. The method of killing the animals, fixation of brains and blocking of three levels from the medulla was exactly the same as described by Zlotnik and Rennie[2]. Eighteen serial sections from each level have been subjected to microscopical scrutiny, making a total of fifty-four sections from each medulla.

The results of this study are summarized in Tables 1 and 2, and it can be seen beyond any doubt that in animals suffering from advanced natural scrapie vacuolation of neurones in the medulla is severe, whereas in healthy animals the numbers of vacuoles are negligible when compared with those of affected

Table 1. Vacuolation of Neurones in Scrapie Sheep

Serial No.	Total No. of vacuoles in 54 sections	Average No. of vacuoles per section	Range per section
S. 3	1,185	22	14– 28
,, 18	1,836	34	10– 56
,, 20	1,476	27	15– 51
,, 22	2,052	38	9– 54
C. 171	3,294	61	29– 78
,, 263	5,832	108	41–215
,, 270	4,266	79	51–123
,, 266	1,260	23	19– 29
,, 268	3,474	64	25– 88
,, 269	1,314	24	7– 43

Table 2. Vacuolation of Neurones in Apparently Healthy Sheep

Serial No.	Total No. of vacuoles in 54 sections	Average No. of vacuoles per section	Range per section
C. 52	41	0·76	0–3
,, 53	57	1·05	0–7
,, 54	None	—	—
,, 55	10	0·18	0–1
,, 97	10	0·18	0–1
,, 98	3	0·05	0–1
,, 99	14	0·26	0–1
,, 100	None	—	—
,, 101	None	—	—
,, 102	16	0·3	0–1

animals. One point, however, must be borne in mind: the finding of even seven vacuoles in a single section of the medulla alone cannot be accepted as significant, and for the diagnosis of scrapie one of the features must be the consistent presence of vacuoles in increased numbers in serial sections throughout the medulla.

I wish to thank Dr. J. T. Stamp, director of the Moredun Institute, for the interest he has taken in this work.

I. Zlotnik

Animal Diseases Research Association,
Moredun Institute, Gilmerton,
Edinburgh. April 25.

[1] Holman, H. H., and Pattison, I. H., *J. Comp. Path. and Therap.* **53**, 231 (1943).
[2] Zlotnik, I., and Rennie, J. C., *J. Comp. Path. and Therap.*, **67**, 30 (1957).
[3] Bosanquet, Frances D., Daniel, P. M., and Parry, H. B., *Lancet*, ii, 737 (1956).
[4] Pattison, I. H., *Lancet*, i, 104 (1957).

Improved Persistence of Dieldrin Deposits on Sorptive Mud Surface

Laboratory experiments carried out by Hadaway and Barlow[1,2] and by Downs, Bordas and Navarro[3] have shown that solid particles of DDT may disappear from the surface of various types of soils such as are frequently used for the construction of huts in the tropics. It seemed that this disappearance was due to a process of absorption, and the different types of soils vary in their sorptive properties[4].

There is no doubt that this process of sorption into mud surfaces, which seems to occur with all commonly used residual insecticides[3], results also in loss of residual effectiveness under field conditions[4], although the effect may not be as serious as that observed under laboratory conditions where dried mud alone is used as the test surface[4].

So far, pre-spraying the mud surface with a surface-sealing material would appear to be the only practical answer, but attempts in this direction have not yielded satisfactory results[4].

The work reported here deals with experiments on a new type of wettable powder formulation consisting of ground solidified melts of dieldrin and a resinous material. The experiments were based on the assumption that the adjuvant may act as a physical barrier between at least an appreciable part of the toxicant and the sorptive surface, so that sorption might be greatly reduced, and the residual effect accordingly prolonged.

A wettable powder was prepared by mixing equal amounts of powdered dieldrin and powdered coumarone resin, which were then melted together until a homogeneous mixture was obtained. This was cooled and the brittle product finely ground, 'Teepol' being added as wetting agent. The majority of the particles were found to be within the range 10–50μ. The powder thus obtained was sprayed at a dosage of 12·5 mgm. dieldrin/sq. ft. on to laboratory-made panels constructed of dried Tanganyika (Babati) mud, having highly sorptive properties.

Enough panels were sprayed to allow for a series of tests at successive time intervals, using new panels each time. A standard 50 per cent dieldrin wettable powder, applied at twice the dosage of dieldrin, was included for comparison.

The test technique was based on a 30-sec. exposure of house-flies to the insecticidal residues. The exposure method was a 'no-choice' method. Knockdown readings were taken at hourly intervals up to 6 hr. after exposure, and the total number of dead and moribund was recorded after 24 hr. The results are shown in Table 1.

Table 1. Improved Persistence of Dieldrin/Coumarone Resin Solidified Melts on Sorptive Mud Panels

Percentage knockdown and 24-hr. mortality

Product	Age of residue	No. of hours after exposure						
		1½	2	3	4	5	6	24
Standard dieldrin wettable powder (25 mgm. dieldrin/sq.ft.)	2 hours	91	100					100
	1 day	0	3	39	48	52	55	100
	2 days			0	9	17	37	71
	3 days		0	4	4	15	22	56
	1 week					0	2	27
	2 weeks						0	8
Dieldrin/coumarone resin melt (12·5 mgm. dieldrin/sq.ft.)	2 hours	49	85	95	100			100
	1 week	0	12	59	94	100		100
	2 weeks	17	72	97	100			100
	4 weeks	14	45	89	100			100
	10 weeks	11	22	44	78	87	98	100*
	4 months	4	27	67	87	—	100	100*
	7 months	0	2	—	52	57	82	100*
	10 months		0	13	28	44	56	100*

* Panels used for exposure more than once.

Table 1 gives a clear picture of the greatly improved persistence obtained under the test conditions. The standard dieldrin wettable powder gave a 100 per cent kill for a period of one day only on the type of mud used; then mortality figures rapidly fell with time, and the residual effect was completely lost after two weeks. On the other hand, the ground dieldrin/coumarone resin melt showed a high rate of knockdown and 100 per cent mortality throughout the experimental period of 10 months.

The favourable results obtained were shown to be, at least to a certain extent, independent of the ratio in which the two components were melted together. No appreciable differences in persistency over a period of three months were observed in tests with residues from wettable powders based on dieldrin/coumarone resin solidified melts in the ratios 90 : 10, 70 : 30 and 30 : 70.

Preliminary experiments with other insecticides (DDT, γ-BHC and aldrin) showed a similar improvement in persistence of the ground insecticide/resin melt as compared with a wettable powder without coumarone resin, but the results were less satisfactory than with dieldrin at the same dosage-level.

Improvement of the persistence of dieldrin deposits on sorptive mud is not a specific property of coumarone resin only. Similar results can be obtained by using other materials. The adjuvant should preferably be of such a nature that it can be conveniently melted with dieldrin; that the melt forms a brittle solid after cooling, so that it can easily be ground; and that the adjuvant itself is not sorbed into the mud. Synthetic and natural resins, asphaltic bitumens, petroleum and coal-tar pitches, the naturally occurring asphaltites such as gilsonite and sulphur were all tested in the same way. Chlorinated polyphenyl ('Aroclor 5460', obtained from Monsanto Chemicals, Ltd., London), colophony, gilsonite and sulphur were particularly satisfactory. With residues of 25 mgm. dieldrin + 25 mgm. adjuvant/sq. ft., a high rate of knockdown and a 100 per cent 24-hr. mortality was obtained throughout the testing period of three months, whereas the standard dieldrin wettable powder at the same dosage gave a similar performance to that mentioned in Table 1.

Although the nature of this phenomenon is not yet fully understood, there are clear indications that sorption is appreciably reduced and a sufficient amount of insecticide remains effective on the surface for prolonged periods. The work is still continuing, and will be reported in full elsewhere. I should like to thank my colleagues in this Laboratory for their help and criticism and also the management of "Shell" Research, Ltd., for permission to publish this work.

PH. GEROLT

Woodstock Agricultural Research Centre,
"Shell" Research, Ltd.,
Sittingbourne, Kent.
May 30.

[1] Hadaway, A. B., and Barlow, F., *Nature*, **167**, 854 (1951).
[2] Hadaway, A. B., and Barlow, F., *Bull. Ent. Res.*, **43**, 281 (1952).
[3] Downs, W. G., Bordas, E., and Navarro, L., *Science*, **114**, 259 (1951).
[4] Barlow, F., and Hadaway, A. B., *Bull. Ent. Res.*, **46**, 547 (1955).
[5] Rajindar Pal and Sharma, M. I. D., *Ind. J. Malar.*, **6**, 251 (1952).
[6] Hadaway, A. B., *W.H.O. Bull.*, **14**, 813 (1956).

Sensitivity of Light-inhibited Seeds to Certain Spectral Regions

IN recent years important progress has been made in our knowledge of the light-dependent processes in plant development. Detailed studies of the action spectrum for the photoperiodic control of flowering and for the germination of certain light-requiring seeds, carried out by Borthwick and his co-workers[1], have shown that in both these developmental processes red light is most effective and that under certain conditions infra-red radiation reverses the effect of red illumination. The connexion between photoperiodism and seed germination was further demonstrated by the discovery by Isikawa[2] and by Black and Wareing[3] of the direct photoperiodic control of germination in seeds of a number of species.

As a corollary to our investigations of photoperiodism in the light-requiring seed of *Betula pubescens*[3], a study has been made of the effect of the photoperiodic régime on germination of *Nemophila insignis*, a light-inhibited seed. It has been found that at 21–22° C. these seeds exhibit photoperiodic behaviour with respect to germination, long days inhibiting, and short days permitting, germination. These effects are profoundly modified by temperature. Further details of this work will be published elsewhere.

During this investigation, an examination has been made of the effects of different regions of the spectrum on germination of *Nemophila*. Facilities for a detailed study of the action spectrum were not available and only white, red, blue and infra-red radiation were used. As a source of white light, 'daylight' fluorescent tubes were used. Red light, within the band 5,800–7,000 A., was obtained from red fluorescent tubes in conjunction with red 'Perspex' (*R*.400) as a filter. To obtain blue light, blue fluorescent tubes were used in conjunction with blue 'Perspex' (*B*.705) and copper chloride filters, transmitting the wave-lengths 4,000–5,200 A. Light from a 150-watt tungsten filament lamp passing through the Ilford infra-red filter 207 and a 9·5-cm. thick water screen gave infra-red radiation of the wave-lengths 7,300–10,000 A.

White fluorescent light at an intensity of 1,200 ergs/cm.²/sec. (lower intensities have not been tested) was found to inhibit seed germination at 21–22° C.

Table 1. THE INHIBITORY EFFECT OF BLUE AND RED LIGHT ON THE GERMINATION OF *Nemophila* SEED. TEMPERATURE 21–22° C.

Intensity (ergs/cm.²/sec.)	Percentage germination Red	Blue
3,000	27·5 (89·4)	25·6 (91·6)
2,300	32·4 (87·3)	29·5 (94·2)
1,900	33·3 (88·2)	27·0 (92·3)
1,300	34·5 (91·0)	25·4 (93·7)
1,000	60·0 (96·9)	22·7 (95·0)
800	59·0 (94·4)	19·3 (93·0)
500	55·3 (90·0)	40·5 (92·6)

The figures in parentheses indicate the percentage germination of the dark controls.

Seeds were exposed to red and blue light over a range of intensities at this temperature. The germination percentages obtained under each treatment are shown in Table 1. These results demonstrate that both blue and red light inhibit germination, and that at the lower intensities blue light is more effective.

On the other hand, it has been found in a number of experiments that germination of *Nemophila* seed is not inhibited by infra-red radiation at an intensity of 4,000 ergs/cm.²/sec. From a knowledge of the spectral emission data for 'daylight' fluorescent tubes[4] it can be calculated that in white fluorescent light, at an intensity of 1,200 ergs/cm.²/sec., the infra-red component is approximately 15·6 ergs/cm.²/sec. Thus, it appears unlikely that the inhibitory effect of white light is due to its infra-red content.

These results are not in agreement with the suggestion put forward by Meischke[5], that the germination of seeds of certain species is inhibited by light from a tungsten filament source because the inhibitory effect of the infra-red content overcomes the effect of promotive wave-lengths. The results also contrast with the findings of Baxter-Jones and Bailey[6] for *Lamium amplexicaule*, which tend to support Meischke's hypothesis. Furthermore, it appears that in *Nemophila* seed we have an example of an action spectrum for germination which, because of the greater effectiveness of blue light, is not in accordance with the typical action spectrum elucidated by Borthwick and his co-workers[1], but which is similar to the findings of several Dutch workers[4,7] for the dependence on wave-length for flowering in *Hyoscyamus* and other plants.

In the present investigation it is unlikely that the inhibitory effect of blue light is due to its infra-red component since the light from the fluorescent tubes was filtered through a solution of copper chloride. The infra-red content must therefore have been very low.

It is hoped that in future work a detailed investigation of the inter-relationships between blue, red and infra-red radiation will be carried out.

M. BLACK*
P. F. WAREING

Department of Botany,
University of Manchester.

* Present address: Department of Field Husbandry, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

[1] Borthwick, H. A., Hendricks, S. B., Parker, M. W., Toole, E. H., and Toole, U. K., *Proc. U.S.Nat. Acad. Sci.*, **38**, 662 (1952).
[2] Isikawa, S., *Bot. Mag. Tokyo*, **67**, 51 (1954).
[3] Black, M., and Wareing, P. F., *Physiol. Plant*, **8**, 300 (1955).
[4] Stolwijk, J. A. J., "Wavelength Dependence of Photo-Morphogenesis in Plants" (Wageningen, 1954).
[5] Meischke, D., *Jahrb. Wiss. Bot.*, **83**, 359 (1936).
[6] Baxter-Jones, M., and Bailey, L. F., *Plant Phys.*, **5**, 347 (1956).
[7] Stolwijk, J. A. J., and Zeewaart, J. A. D., *Kon. Ned. Akad. Wetensch.*, C, **58**, 386 (1955).

FORTHCOMING EVENT

Thursday, August 29—Thursday, September 12

Engineering, Marine and Nuclear Energy Exhibition (at Olympia, London).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Research Student in either Engineering or Chemical Engineering or Metallurgy—The Registrar, University College, Singleton Park, Swansea (August 28).

Departmental Assistant (with an honours degree in botany) in the Department of Botany—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (August 30).

Professor of Mechanical Engineering at Santa Maria Technical College, Valparaiso, Chile—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting N.2 (57) (August 30).

Assistant, Grade B, in Physics; and an Assistant, Grade B, in Chemistry—The Principal, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 31).

Electron Microscopist (with a degree in science or equivalent qualification, previous experience in electron microscopy, a good knowledge of electronics, and ability to service the microscope) in the Virus Research Unit, Agricultural Research Council, Cambridge, for work on viruses—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 31).

Professor and Head (with academic qualifications and research or development experience appropriate to a postgraduate department studying gas turbines, jet propulsion engines and rockets, with an increasing emphasis on high-temperature problems and nuclear power) of the Department of Aircraft Propulsion—The Principal, The College of Aeronautics, Cranfield, Bletchley, Bucks (August 31).

Assistant Experimental Officers (2) (preferably with a degree in a biological subject, or at least G.C.E. in five subjects with advanced level in botany, zoology and chemistry) with the Ministry of Agriculture, Fisheries and Food, stationed at Hull and Nottingham, for research on insect control—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.262/7A (September 7).

Assistant Lecturer, Grade A (male), to teach Applied Mathematics and Physics to the standard of General Certificate of Education Ordinary level, at the Dockyard Technical College, Malta—The Director (Y), Education Department, Admiralty, London, S.W.1 (September 9).

Demonstrator in Botany—The Registrar, The University, Leeds (September 9).

Head (with a degree of a British University and appropriate research and administrative experience) of the Department of Science, Royal Technical College of East Africa, Nairobi—Council for Overseas Colleges of Arts, Science and Technology, 1 Woburn Square, London, W.C.1 (September 10).

Senior Lecturer and Lecturer (with previous experience in an institution of higher education, and preferably a member of a main professional Institution) in Engineering at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Council for Overseas Colleges, 1 Woburn Square, London, W.C.1 (September 12).

Assistant in Botany—The Secretary of University Court, The University, Glasgow (September 13).

Lecturer in Natural Philosophy (Electronics)—The Secretary, The University, Aberdeen (September 15).

Lecturer in Chemistry (Inorganic) at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 20).

Lecturer in the Department of Geology, Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 20).

May and Baker Research Fellow (graduate in science who has specialized in biochemistry), to undertake research work on plant growth regulating substances—The Registrar, Wye College, near Ashford, Kent (September 21).

Lecturer in Mathematics at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 28).

Lecturer in Mathematics; and a Lecturer in Mathematical Statistics at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 30).

Lecturer in the Department of Geology, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 30).

Lecturers or Assistant Lecturers in Mathematics—The Registrar, The Manchester College of Science and Technology, Manchester 1 (September 30).

Regius Professor of Physiology in the University of Aberdeen—The Private Secretary, St. Andrews House, Edinburgh 1 (September 30).

Professor of Horticulture—The Registrar (Room 9, O.R.B.), The University, Reading (October 18).

Chemist/Assayer (with a first- or upper division second-class honours degree in chemistry, and preferably two years postgraduate research or experience as a chemist) in the Department of Geological Survey, Government of Northern Rhodesia, to carry out assays of ores, analysis of minerals and rocks and other determinations in the Geological Survey Laboratories—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/3/03.

Fison Research Fellow (suitably qualified graduate) in the Department of Biological Sciences, for work in connexion with nutritional studies in relation to plant virus diseases—The Registrar, Wye College, near Ashford, Kent.

Geologist (with a first- or second-class (upper division) honours geology degree) with the Government of Sarawak, for duties mainly concerned with field mapping—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/127/01.

Junior Technician/Technician (preferably with an interest in biochemistry) in the Clinical Pathological Laboratory—The Secretary, The National Hospitals for Nervous Diseases, Queen Square, London, W.C.1.

Laboratory Technician (Zoology) (preferably with experience of biological techniques)—The Registrar (ZT), Queen Mary College (University of London), Mile End Road, London, E.1.

Specialist Officer (Horticulturist) (with a good honours degree in an appropriate branch of science followed by at least two years postgraduate training or approved experience, and normally not less than 23 or more than 30 years of age) in the Region of Northern Nigeria, to develop the cultivation of fruit trees and tree crops (citrus, coffee, cocoa, oil palm, etc.): test local and imported material; develop techniques of propagation cultivation and management; and ascertain most suitable root crops in various areas—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/408/033.

Zoologist (male, preferably with a first- or good second-class honours degree), for work on the maintenance and infection of bilharzia snail vectors and other problems of bilharzia disease—The Director, Medical Research Council, Bilharzia Research Group, Winches Farm, Hatfield Road, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

South East London Technical College: Department of Engineering and Applied Physics. Prospectus No. 2, Session 1957–58. Pp. 55. (London: London County Council, 1957.) [117

Colonial Office. The Colonial Territories, 1956–1957. Pp. xxv+185. (Cmnd. 195.) (London: H.M. Stationery Office, 1957.) 7*s.* net. [117

The Plastics Institute. Twenty-sixth Annual Report. Pp. 24. (London: The Plastics Institute, 1957.) [117

Third Annual Report of the Marshall Aid Commemoration Commission for the year ending September 30, 1956. Pp. 8. (Cmnd. 167.) (London: H.M. Stationery Office, 1957.) 6*d.* net. [117

Other Countries

Merentutkimuslaitoksen Julkaisu. No. 170: Vedenkorkeusarvoja 1949 ja 1950. By Eugenie Lisitzin. Pp. 79. No. 171: Die Eisverhältnisse in den Finnland Umgebenden Meeren in Den Winter 1951–1955. Redigiert von Heikki Simojoki. Pp. 23. No. 172: Vedenkorkeusarvoja 1951 ja 1952. By Eugenie Lisitzin. Pp. 78. No. 173: Jääpeitteen Laajuuksien Vaihtelu Vuosina 1931–56. By Laatinut Erkki Palosuo. Pp. 40. No. 174: Die Eisverhältnisse in den Finnland Umgebenden Meeren im Winter 1955–56. Redigiert von Erkki Palosuo. Pp. 14. No. 175: The Frequency of Extreme Heights of Sea-Level Along the Finnish Coast. By Eugenie Lisitzin. Pp. 12. (Helsinki: Merentutkimuslaitos, 1956 and 1957.) [87

Université de Paris. Travaux et Mémoires de l'Institut d'Ethnologie. Tome 60: Contes et Léendes des Oubykhs. Par Prof. Georges Dumezil. Pp. xiii+103. 800 francs; 3 dollars. Tome 61: Coutumes et Croyances des Falachas (Juifs d'Abyssinie). Par W. Leslau. Pp. ix+98. 1,000 francs; 3.60 dollars. (Paris: Institut d'Ethnologie, 1957.) [87

British Territories in Borneo. Annual Report of the Geological Survey Department for 1956. By F. W. Roe. Pp. x+212+37 plates. (Kuching, Sarawak: Geological Survey Department, 1957.) [87

Ontario Research Foundation. Annual Report, 1956. Pp. 31. (Toronto: Ontario Research Foundation, 1957.) [87

Verhandelingen van het Koninklijk, Nederlandsch Geologisch-Mijnbouwkundig Genootschap. Geologische Series, Deel 18. Gedenkboek F.A. Vening Meinesz. Pp. lv+309. ('S-Gravenhage: N.V. Boekenkunstdrukkerij V/H Mouton and Co., 1957.) [87

The Carlsberg Foundation's Oceanographical Expedition Round the World, 1928–30, and "Dana" Expeditions. Dana-Report No. 43: Paralepididae II (Macroparalepis): Taxonomy, Ontogeny, Phylogeny and Distribution. By V. Ege. Pp. 10. (Copenhagen: Andr. Fred. Høst et Fils, 1957.) 28 Danish Kr.; 28*s.* [87

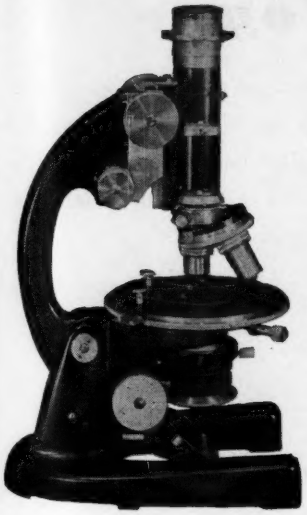
Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £7/10/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2
Telephone Number: Holborn 4743

All rights reserved. Registered as a newspaper at the General Post Office

SWIFT MODEL P POLARISING MICROSCOPE



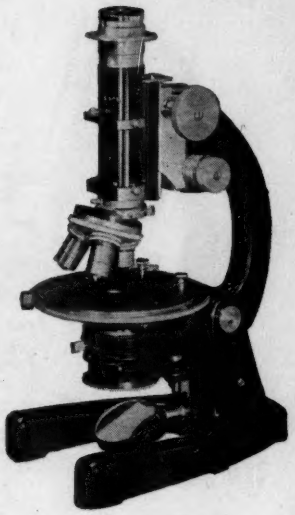
★ *A specimen viewed in polarised light may reveal unexpected information, and in addition to their analytical value, polarising elements afford dark ground effects and a sensible means of light control.*

★ *The Swift Model P is a versatile instrument for investigations in any field. Designed with standard R.M.S. optical assemblies it can be set up as critically as any conventional instrument.*

★ *The polarising elements are inserted with simple finger pressure without any diminution or distortion of the field or need for further adjustment.*

★ *The attractive features of a polarising microscope are available at little extra cost, for the Model P is based on the rationalised "Century" stand.*

★ *Additional analytical accessories may be added subsequently.*



A new catalogue showing the potentialities of this instrument and giving full specifications is available, post free, from :—

JAMES SWIFT & SON LTD. 113-115A CAMBERWELL ROAD, LONDON, S.E.5 RODney 5441

DIGITAL DATA PROCESSING

The SHAPE Air Defense Technical Center is increasing its activity in the field of high-speed digital data-processing.

Applications are invited from suitably qualified persons with interest in one or more of the following fields:

Digital computation.
High-speed analog-digital conversion.
Computer input and output devices.
Transistor and magnetic-core techniques, applied to computers.
Cathode-ray tube displays.

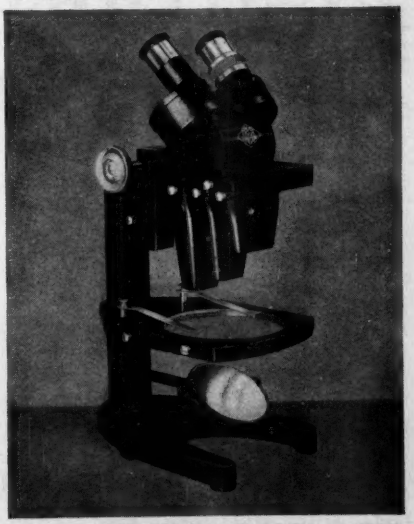
The basic salaries will be based on the European average for corresponding background and experience. Successful applicants from foreign countries will benefit by a number of privileges including a foreign allowance of the order of 70 per cent of the basic salary, and reimbursement of the cost of moving their families and household effects to The Hague and back to their country of origin on termination of the contract. The total income is tax free in the Netherlands.

Applications, containing detailed information on training and past experience, should be sent as soon as possible to:

The Director, SADTC, P.O. Box 174, The Hague, Netherlands.

The Hall-mark of a PRIOR *Precision-built Microscope*

STEREOSCOPIC MICROSCOPES



W. R. PRIOR & CO. LTD.
LONDON ROAD, BISHOP'S STORTFORD, HERTS.

BECK NO. 47 LONDON

Pre-eminent in Design, Workmanship & Performance

R. & J. BECK LTD, 69 MORTIMER ST. LONDON, W1

A new catalogue

Our new illustrated catalogue, which is just coming off the press, describes well over sixty different graticules for microscopy. In it we are introducing a number of new patterns which will be available shortly.

Please write to us for your copy of this catalogue which is virtually a Handbook of Graticules.

Graticules LIMITED

57-60 HOLBORN VIADUCT, LONDON, E.C.1

Phone: CENtral 2717/8 Grams: Rheinberg, Cent., London

Green's Lens Tissue

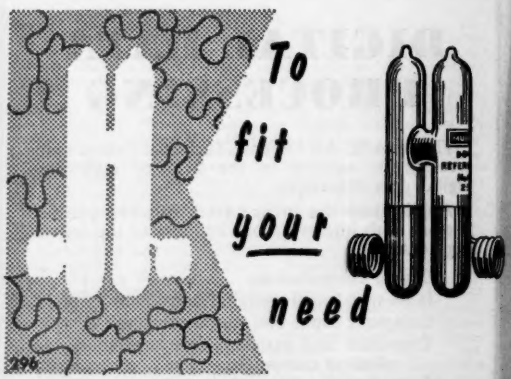
This amazing Tissue is definitely the finest Lens Cleaning material available. Moreover, it is just what microscopists and photographers have been seeking for many years.

Write at once for Price List NG/T

J. BARCHAM GREEN LTD.

Hayle Mill, Maidstone, Kent, England

MADE IN ENGLAND



D-845 INDUSTRIAL WESTON REFERENCE CELLS

Use Muirhead D-845 Reference Cells. Reproducible, tough and reliable. Automation and other scientific applications require voltage standards which stay put. D-845 cells remain unaffected by ambient temperature changes. Voltage variation is less than 3 millionths of a volt per °F over an ambient range of at least 40-100°F.

MUIRHEAD

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

PRECISION ELECTRICAL INSTRUMENT MAKERS

Phone: Beckenham 0041. *Telegrams & Cables:* MUIRHEAD, BECKENHAM

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, August 24, 1957